SAE Journal

DECEMBER 1955

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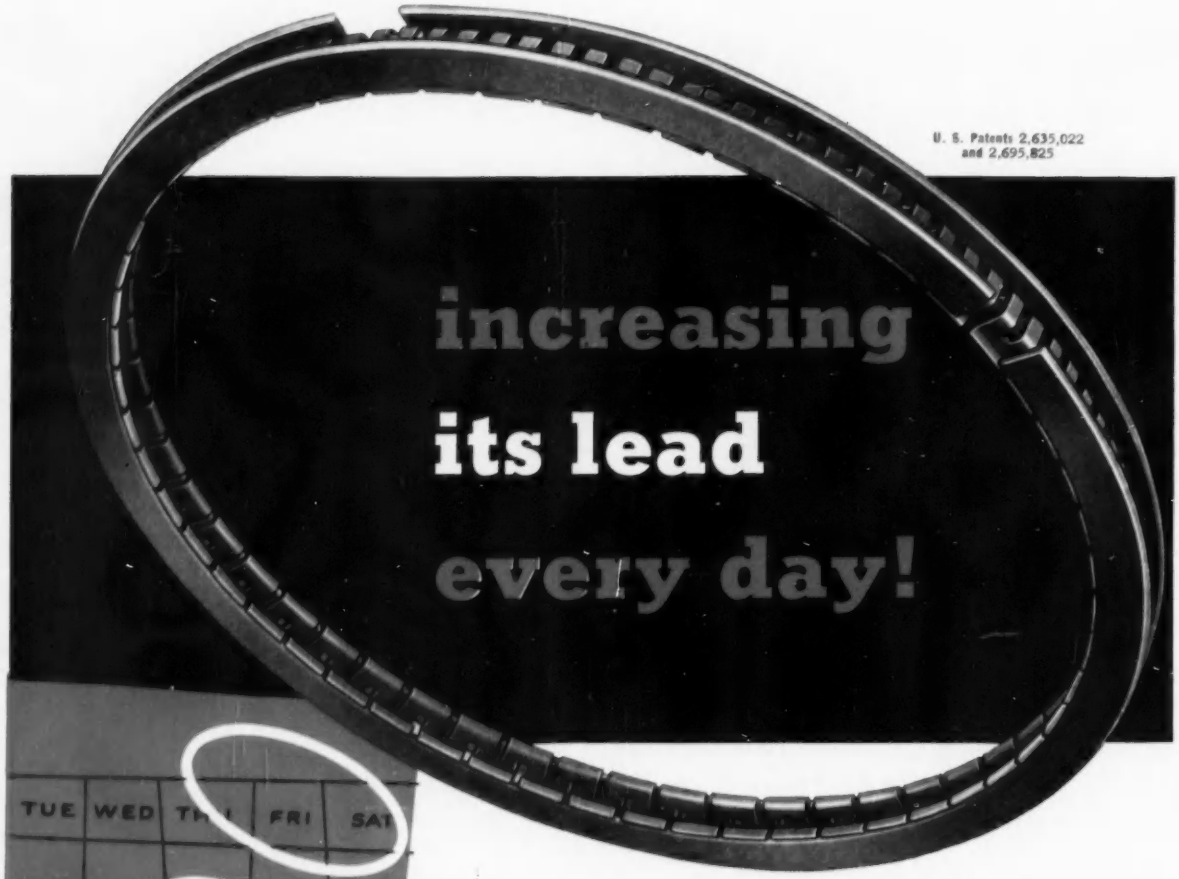
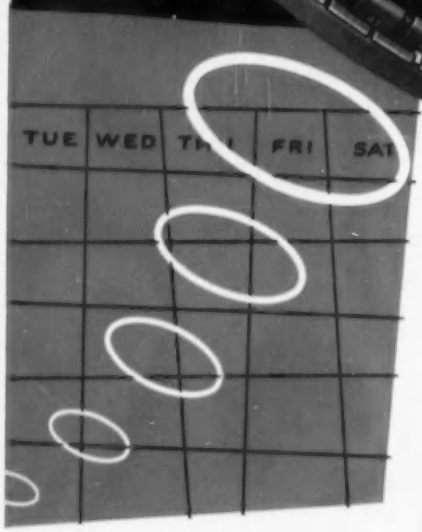
Published by The Society of Automotive Engineers





New **PERFECT CIRCLE** type "98" chrome oil ring!

Of the 6,474,531 U.S. passenger cars produced from Jan. 1 through Oct. 29 more than half* were equipped with the new Perfect Circle type "98" chrome oil ring!

Better than any other oil ring for new high-compression, high-vacuum overhead valve engines!

- Uniform pressure on entire circumference!
- Multiple tiny springs exert both side and radial pressure!
- Provides maximum oil drainage!
- Constant flexing retards carbon accumulation!

Perfect Circle Corporation,
Hagerstown, Indiana
The Perfect Circle Co., Ltd.,
Toronto, Ontario

*52% were new Perfect Circle Type "98" Chrome Oil Rings.
48% were all other oil ring types combined, including other Perfect Circle oil ring types.

FACTS

about

NEW DEPARTURE

BALL BEARINGS

New Departure split inner ring bearings are separable, facilitating cleaning, inspection and assembly into the engine. They carry heavy thrust loads from either direction and will also support major radial loads.

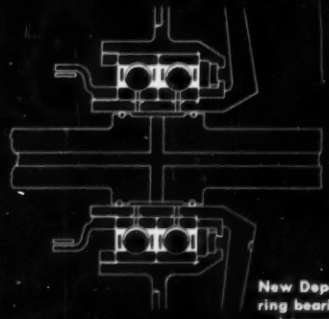
Research develops aircraft bearings for extreme speeds and temperatures

With jet aircraft flying higher and faster than ever before, ball bearings are being called on to meet increasingly severe conditions. For example, bearings that support the turbine wheels are subjected currently to temperatures up to 500° F. at high speeds and heavy thrust loads.

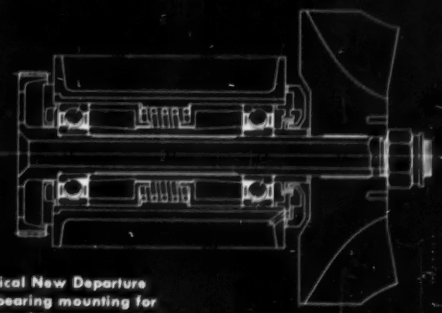
Anticipating still greater demands in the future, New Departure's Aircraft Research Program is already developing bearings for operational speeds of over 100,000 rpm and temperatures moving up towards 1000° F.

Typical of the bearings used in jet engines are New Departure's split inner ring types. These bearings are giving satisfactory performance in production engines today at extremely high speeds and heavy thrust loads. Write for full details.

TYPICAL JET AIRCRAFT APPLICATIONS



New Departure split inner ring bearing mounting for jet engine mainshaft



Typical New Departure ball bearing mounting for alternator drive power turbine

NEW DEPARTURE • DIVISION OF GENERAL MOTORS • BRISTOL, CONN.

SAE JOURNAL, December, 1955, Vol. 63, No. 12. Published monthly except two issues in January by the Society of Automotive Engineers, Inc. Publication office, at 10 McGovern Ave., Lancaster, Pa. Editorial and advertising department at the headquarters of the Society, 29 West 39th Street, New York 18, N. Y. $1 per number; $10 per year; foreign $12 per year; to members 50 cents per number, $5 per year. Entered as second class matter, September 15, 1948 at the Post Office at Lancaster, Pa., under the act of August 24, 1912. Acceptance for mailing at special rate of postage provided for in the Act of February 28, 1925, embodied in paragraph (d-2), Sec. 34.40, P. L. and R., of 1948. Additional entry at New York, N. Y.

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available with
LOW COST

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***Steel protection—top and bottom*—gives sensationally longer life to rings and grooves.**

This ring is *integrally cast* into the piston . . . positioned so that when the grooves are machined, the top ring groove is *lined with steel* and has islands of aluminum for ring cooling. This Intra-Cast steel-protected groove resists enlargement and materially reduces top ring land wear and rounding. And, it does it at far less cost than other methods.

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New, complete seat-units of full-depth molded AIRFOAM dispense with over-bulky assemblies–*and give the space saved to drivers and passengers.* They also permit new production economies, while adding style, glamour and a better ride!

For more information–and significant case histories – contact Goodyear, Automotive Products Dept., Akron 16, Ohio.

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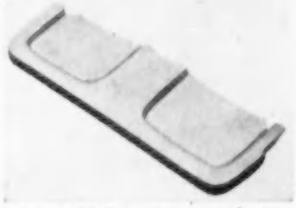
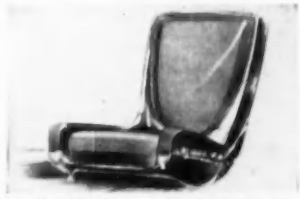
AIRFOAM *makes interiors roomier, more luxurious*



Premolded AIRFOAM *replaces expensive handwork– looks even richer*



Exciting new seating ideas become practical with AIRFOAM

AIRFOAM *can be your greatest sales-aid in years*

Airfoam – T. M. The Goodyear Tire & Rubber Company, Akron, Ohio.

Bendix Products Division

For a quarter of a century, Bendix Products Division has maintained leadership in many important automotive components. Today, Bendix* Power Brakes, Power Steering, wheel brakes, constant velocity joints and hydraulic remote controls are still the industry's choice for outstanding performance.

Bendix-Skinner Division

With a new and modern plant Bendix-Skinner Division, originator of micronic filtration, has greatly increased its capacity to meet the design needs and production requirements of the automotive industry with over 350 types of filters.

Scintilla Division

As the world's foremost producer of ignition equipment, the Scintilla Division is particularly capable of supplying high-efficiency magnetos, battery ignition units, switches, electrical connectors, and fuel injection equipment.

Eclipse Machine Division

Eclipse Machine Division has manufactured well over 100,000 Bendix* Starter Drives. Stromberg* Carburetors produced by Eclipse have contributed materially to automotive progress and the Bendix* Automotive Electric Fuel Pump is a recognized leader in its field.

Bendix Radio Division

The fact that Bendix* Radio not only is deeply engaged in production of all types of radio equipment, but is equally familiar with automotive problems as well, makes Bendix Radio the ideal choice of manufacturers interested in quality performance at production prices.

*REG. U.S. PAT. OFF.

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AVIATION CORPORATION

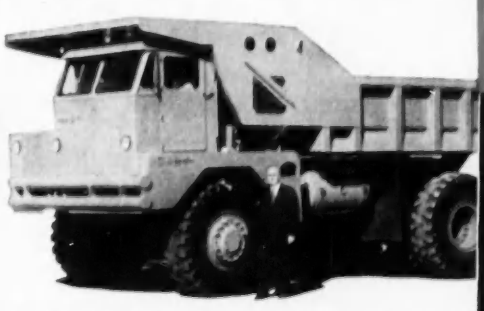
Over the Road... or Off the Highway

WAUKESHA

MODEL	Cyl.	*Features	Bore and Stroke	Displ. Cu. In.	Max. Torque @ RPM	Max. HP	RPM
TURBO-SUPERCHARGED DIESELS							
135-DKBS	6	ACTV	4¼x5	426	400-1800	185	2800
148-DKBS	6	ACTV	5¼x6	779	706-1800	280	2100
WAKDBS	6	ACTV	6¼x6½	1197	1062-1600	352	1800
NORMAL DIESELS							
185-DLC	6	A	3½x3¾	216	152-1200	60	2400
190-DLCA	6	AC	3¾x4	265	191-1400	85	2800
195-DLCA	6	AC	4 x4	302	221-1800	98	2800
135-DKB	6	ACV	4¼x5	426	328-1600	147	2800
148-DKB	6	ACV	5¼x6	779	584-1000	200	2100
WAKDB	6	ACV	6¼x6½	1197	845-1000	258	1800
GASOLINE							
185-GLB	6	A	3½x3¾	216	176-1400	67	2400
190-GLB	6	A	3¾x4	265	220-1200	77	2400
195-GKA	6	ACV	4⅛x4	320	243-1600	122	3000†
MZA	6	A	4¼x4¾	404	289-1000	128	2800†
135-GKB	6	ACV	4¼x5	426	337-1200	147	2800†
135-GZB	6	ACV	4⅜x5	451	354-1200	153	2800†
140-GKB	6	ACV	4½x5½	525	425-1000	177	2600†
140-GZB	6	ACV	4⅝x5½	554	448-1100	188	2600†
145-GKB	6	ACV	5¼x6	779	595-1000	240	2400†
145-GZB	6	ACV	5⅜x6	817	630-1100	250	2400†
WAKB	6	ACV	6¼x6½	1197	1000-1000	280	1800

***FEATURES:** A—Aluminum Alloy Pistons; C—Counterbalanced Crankshaft; T—Turbo-Supercharged; V—Vibration Dampner.

†These engines rated at higher hp and rpm for fire engine service. *Send for Bulletin 1079 for LPG ratings and complete listing of engine hp and speed ratings.*

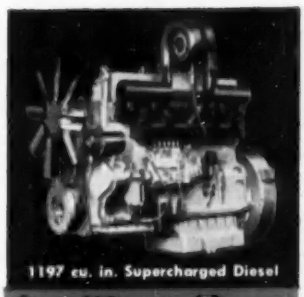


50th Anniversary Waukesha Motor Company 1906-1956

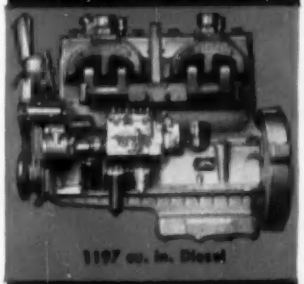
280-R

WAUKESHA MOTOR COMPANY • WAUKESHA, WIS.

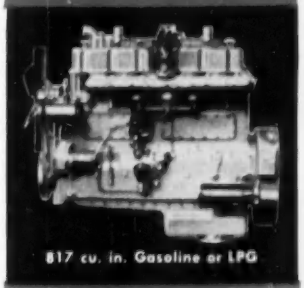
NEW YORK • TULSA • LOS ANGELES



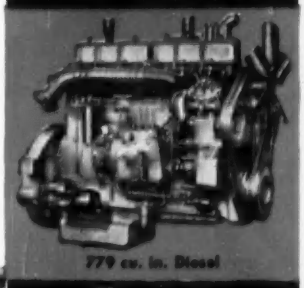
1197 cu. in. Supercharged Diesel



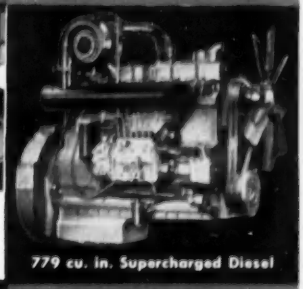
1197 cu. in. Diesel



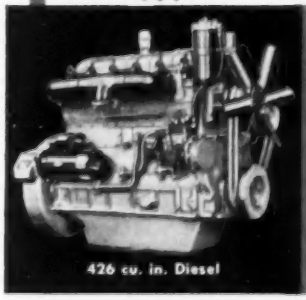
817 cu. in. Gasoline or LPG



779 cu. in. Diesel

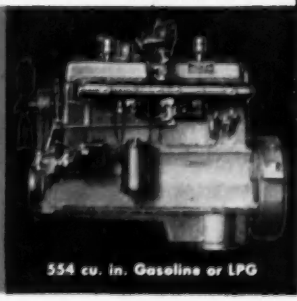


779 cu. in. Supercharged Diesel

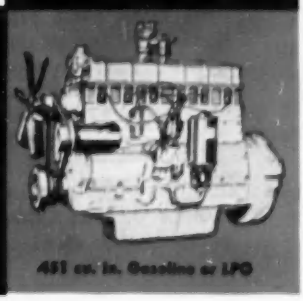


426 cu. in. Diesel

426 cu. in. Supercharged Diesel



554 cu. in. Gasoline or LPG



451 cu. in. Gasoline or LPG

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...and GENERAL PLATE Composite Metals Provide Performance plus Economy

Virgin metals and alloys have their limitations, and to overcome them . . . to get the *exact* performance you want . . . General Plate Composite Metals are the answer. They give you broadened physical and metallurgical characteristics . . . meet your specific requirements closer and do the job better, at lower costs.

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General Plate products include . . . precious metals clad to base metals, base metals clad to base metals, thin-gauge rolling composite contacts, buttons and rivets, *Truflex*® Thermostat Metals, *Alcuplate*®, platinum fabrication and refining, #720 Manganese Age-hardenable Alloy. Write for complete information and Catalog PR-700 today.

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GENERAL PLATE DIVISION
1112 FOREST STREET, ATTLEBORO, MASS.

For the Sake of Argument

Bounce Control . . .

By Norman G. Shidle

Ideas have much in common with rubber balls. The way they bounce depends on:

- Where they start from;
- The force with which they are thrown, dropped, tossed, or pushed;
- The character of the surface on which they hit;
- The angle at which they hit;
- The "texture" of the ball or the idea itself;
- The ambient temperature in which the bouncing takes place.
- All these and more factors influence the bounce of a rubber ball—and the rebound of an idea we bounce on others.

The actual bounce, in fact, is determined by the particular coincidence of all these factors peculiar to the immediate situation.

These complex interrelationships make futile any attempt to control a specific bounce by quantitative predetermination of the forces involved. Even to try for such predetermined physical estimate of performance is to misconstrue the character of the problem. It must be accepted to start with as an exercise in "awareness". We must not be led astray by the neatness with which similes from physics seem to be applicable.

The 20-game winner on a big league pitching staff has to make a baseball perform according to the laws of physics. . . . But he doesn't learn to do it by *studying* the laws of physics. He learns by pitching long and often to all kinds of batters—and by growing "awareness" of what happens to each kind of pitch. He learns to throw curves by throwing them until he gets the "feel." He wouldn't know a T-square from a slide rule.

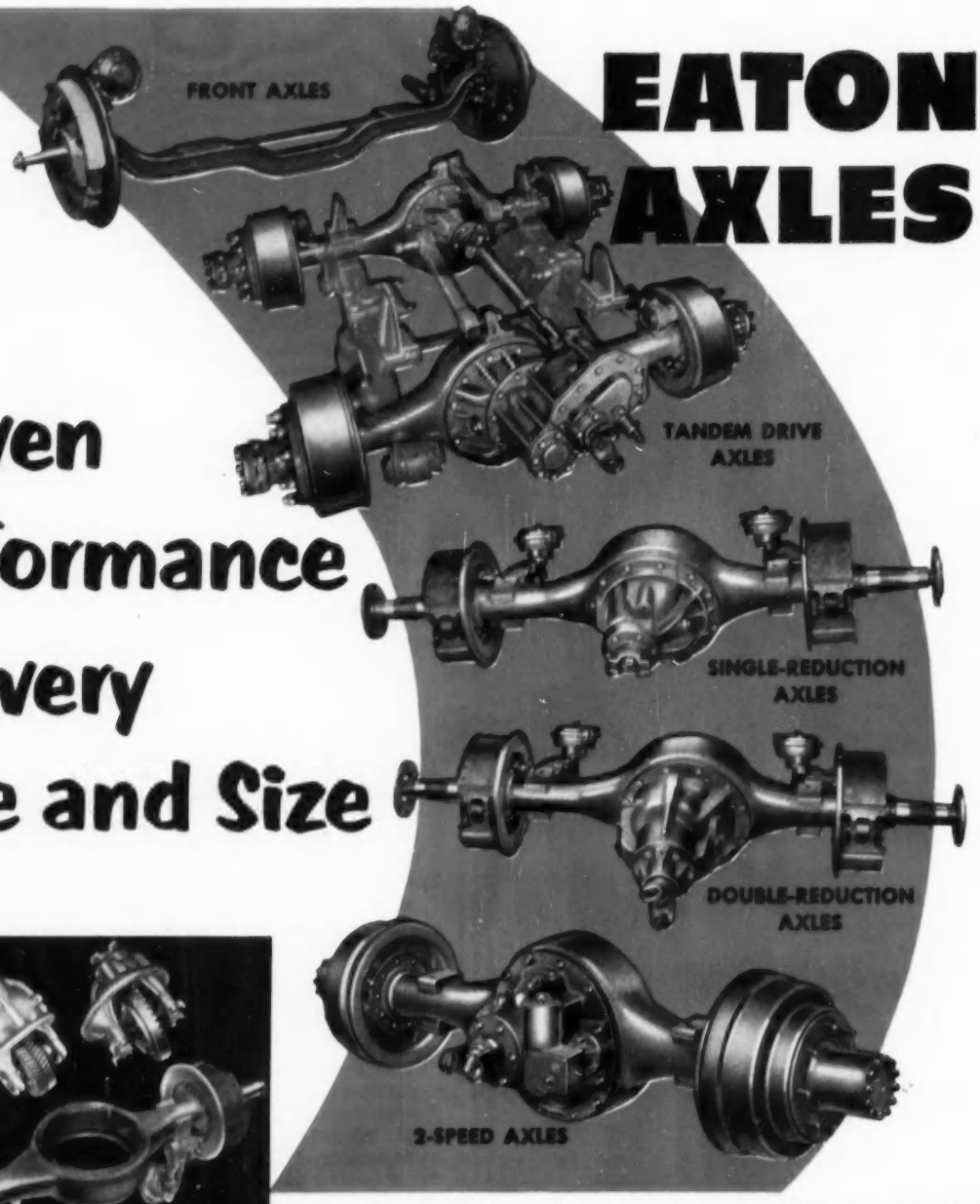
So it is with the people whose ideas usually seem to bounce the way they want them to. Their "awareness" of bounce after bounce gives them cumulative "feel". . . .

And one thing such "control" artists find out early in the growth of their awareness:

Hardly anybody enjoys chasing after the ideas you throw.

EATON AXLES

Proven Performance in Every Type and Size



The rugged housing used in famous Eaton 2-Speeds is also used for Eaton single-reduction and double-reduction axles—the three heads are interchangeable.

Behind every Eaton Axle there is almost a half-century of truck axle manufacturing experience. The advanced engineering and quality construction which have made Eaton 2-Speeds famous for stamina and low-cost hauling are also found in Eaton single-reduction, double-reduction, tandem drive axles, and front axles. In more than two million motor trucks, Eaton experience and engineering know-how are reflected in outstanding performance records, minimum hauling costs, and longer vehicle life.

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MANUFACTURING COMPANY
CLEVELAND, OHIO

PRODUCTS: Sodium Cooled, Poppet, and Free Valves • Tappets • Hydraulic Valve Lifters • Valve Seat Inserts • Jet Engine Parts • Rotor Pumps • Motor Truck Axles • Permanent Mold Gray Iron Castings • Heater-Defroster Units • Snap Rings Springtites • Spring Washers • Cold Drawn Steel • Stampings • Leaf and Coil Springs • Dynamatic Drives, Brakes, Dynamometers

SAE Journal

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SAE JOURNAL PUBLICATION OFFICE
Business Press, Inc.
10 McGovern Ave.
Lancaster, Pa.

EDITORIAL OFFICE
29 West 39 St.
New York 18, N. Y.
Tel.: LOngacre 5-7174

ADVERTISING OFFICES
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1905 S.A.E. GOLDEN ANNIVERSARY 1955

Contents—December, 1955

Bendix Products Division

A good reliable source

FOR AUTOMOTIVE EQUIPMENT

From four wheel brakes to the latest development in power braking, Bendix Products Division has demonstrated its unique ability not only to keep pace but *actually to anticipate* the industry's requirements for the latest and most efficient in automotive components.

TYPICAL EXAMPLES

BENDIX LINKAGE TYPE POWER STEERING—Because Bendix* Power Steering is of the linkage type, manufacturers find it especially adaptable for production line installation without extensive engineering changes. Manufacturers can now meet the ever-increasing demand for power steering more efficiently and more economically with Bendix Linkage Type Power Steering.

BENDIX LOW PEDAL POWER BRAKE—Specified by more car manufacturers than any other make, Bendix* Low Pedal Power Brake makes possible quick, sure stops by merely pivoting the foot from the go to the stop control. No need to lift the foot and exert leg power to bring the car to a stop. Result—more driving comfort, less fatigue and greater safety.

*REG. U. S. PAT. OFF.

BRAKES • POWER STEERING • POWER BRAKING • CONSTANT VELOCITY UNIVERSAL JOINTS • HYDRAULIC REMOTE CONTROLS

BENDIX PRODUCTS DIVISION **SOUTH BEND** INDIANA DIVISION OF Bendix AVIATION CORPORATION

Export Sales: Bendix International Division, 205 East 42nd Street, New York 17, N. Y.

V. G. RAVIOLO, director, advanced product study and engineering research, Ford Motor Co., looks at present trends to predict . . .

Tomorrow's Engines

Based on paper "Future Trends in Automotive Power Plants" presented at a meeting of the Atlanta Section of the Society of Automotive Engineers on May 2, 1955.

ENGINE OUTPUT—The horsepower race will continue. During the next five or six years engines will increase their power about 25%. Seven to eight percent will come from increased compression ratios. From freer breathing induction systems, 5 to 10% improvement is possible. From higher engine speeds we can expect another 10%. After that, the next step must be larger engine displacement without greater weight and without greater cost. These high horsepower engines will be used in cars that will require the same power at low speed as today's cars. At high speed the temperatures and pressures will be more severe, but there will be a lower percentage demand at road load. This will make cooling difficult and create manifold problems.

VALVES—L-head engines will be used less and less as fuels get better. F-head engine cylinder heads are almost as difficult to cast as heads for an overhead valve engine, and the block is almost as difficult as the block for an L-head. With the intake valve in the block, valve seat distortion and valve cooling problems are the same as in the L-head. So most future engines will use overhead valves.

COMPRESSION RATIO—By 1957–1958, compression ratios will be 10/1 or higher with a requirement of 100 plus research octane number fuels. Ultimately, I believe, compression ratios will go to 12/1. If the ratio is increased from 7/1 to 12/1, thermal efficiency is increased from 27 to 30%. That means a gain in fuel economy of about 20 to 30% or an increase in gasoline mileage from 18 to 22½ mpg.

TYPE OF ENGINE—The trend to the V-8 engine will continue. However, the in-line six will not be put entirely out of business for five or ten years, at least, because it is compact, simple to maintain, and initial cost is low. The development of a V-6 is unlikely because it would cost almost as much as a V-8. (It would have two cylinder heads and much surface to machine.) Gas turbines will be in production by 1965 or sooner in a low volume specialty car. Biggest problem is to find metals and lubricants that can stand up during the constant, high (2000 F) temperatures in the burner and turbine blades.

BORE-STROKE RATIO—The cylinder bore is getting larger and the stroke is getting shorter. This gives room in the combustion chamber for larger valves and better breathing. There is room for bigger bearings and stiffer crankshafts. There is much lower friction and less wear. Ratios of 1.5 or 2 to 1 are feasible; although probably, because of the shape of engines, bore-stroke ratios will remain about what they are today.

CONTINUED ON NEXT PAGE

CAMSHAFT—Overhead camshaft engines have been overlooked in this country. If costs and gear drive noise can be reduced, and valve lash controlled, the overhead cam will increase rpm 10%.

FUELS—By 1957–1958 we will need a great deal of 100 plus octane number fuel to take care of the many cars with compression ratios of 10/1 or higher. By 1960–1962 the range of compression ratios of available cars will be narrowed, resulting in a single large volume gasoline pool. There is a promising future for liquid petroleum gas. It is economical, it burns very clean (thereby decreasing engine maintenance and increasing engine life) and is very easily carbureted. It is not very safe, however, and must be handled and stored under pressure. Whenever special arrangements can be made for safe handling there is much to be gained from using LPG.

DIESEL ENGINES—The market for diesel engines is slowly disappearing. The advantage of the diesel has been tied to a low-cost fuel. To capitalize on fuel economy, diesels have been rated downward in output and in rpm. So, they have developed a reputation for long life. Now, this is not inherent in the diesel but is simply a matter of design. The difference in the theoretical cycle between gasoline and diesel is far over-estimated when used for a passenger car. Many fleet operators are finding that they can put more gasoline-powered vehicles on the road and show more net profit on their investment over five or six years than they could with diesels. As fuel refinery techniques are improved and better low cost fuels become available, and as rising compression ratios increase the efficiency of gasoline engines, diesels will fade out of the picture, unless a completely new low-cost design can be developed.

LUBRICANTS—When gas turbines are introduced there will be a need for lubricants that can withstand operating temperatures as high as 500 F. Some metal temperatures may well reach 650 F where oil will contact. Probably synthetic lubricants will be required to meet gas turbine conditions.

NEW MATERIALS—The search for larger engine displacement per dollar will require new manufacturing techniques and new materials. High-strength iron alloys are already being used. Powdered metals which can be made as strong as iron and die cast into complex forms will be used more and more. Plastics will have their place, too, as in nylon carburetor valves. Aluminum and magnesium alloys are coming down in cost and will be used for small covers, manifolds, and small structural parts.

PRODUCTION METHODS—Foundry techniques will be improved. This will permit decreasing the thickness of cylinder block walls in many places, thereby increasing displacement and horsepower per unit weight. Composite welded engines are a possibility—as proved by the Consul and Zephyr engines. This will reduce weight and costs. Complex parts such as blocks and heads can be made from individually molded parts which are then furnace-brazed into assemblies. This has already been demonstrated in small quantities with aluminum. I feel certain this technique can be adapted to iron which costs so much less.

MULTIPLE CARBURETION—The most obvious advantage of a four-venturi carburetor is better breathing which results in higher horsepower. One pair of throttles opens first. A second pair opens afterwards, giving economy gains because of better mixing at low speeds. This is possible because the first stage venturi is made very small—for good mixing—and the second stage is made large to get full power. Where the four-venturi carburetor is made so that all throttles are opened simultaneously and each venturi is feeding two cylinders, higher torque is obtained. If we can combine these two arrangements, that is, make four-venturi carburetors feed cylinders in pairs and also feed them in the combination that we use today for high speeds, we will be able to get both high torque and high horsepower.

CONTINUED ON NEXT PAGE

COMBUSTION CHAMBERS—As we go to higher compression ratios, we'll need engines with higher mechanical octane numbers, greater smoothness, and resistance to deposits and fouling. Ford favors a chamber design with in-line valves because it gives better economy during part-throttle operation than a hemispherical chamber gives.

FUEL INJECTION—We will see fuel injection in American cars within five years. We have designs today that are almost as cheap as a four-venturi carburetor.

SUPERCHARGERS—Supercharging is still a very costly way of getting better performance. They have a place in the sports car but I don't expect to see them in the standard passenger car in any large numbers.

(Complete paper on which this abridgment is based is available from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Cabin Mockup . . .

. . . facilitates prompt, lower cost development of environmental control and minimizes the necessity for flight testing.

Based on paper by **L. H. Schreiber,** Convair Div., General Dynamics Corp.

SUCCESSFUL environmental control of a supersonic bomber requires satisfactory design and development of a number of major elements comprising the environmental control system. To evaluate the design as early as possible, a series of ground tests is run on these elements, individually and in combination. One phase of this ground testing involves the use of a cabin mockup.

At Convair we have fabricated a full-scale cabin mockup and installed it in a chamber in which flight environmental conditions were simulated. It was used to solve problems affecting the air conditioning system size, the cabin supply air distribution system configuration, and the electronic equipment performance.

The cabin mockup test set is shown in Fig. 1. Cabin supply flow is circulated in a closed system with its temperature controlled by heat exchanger cooling or electrical heating. High-speed-flight cabin skin temperatures were obtained with radiant heaters. Cooling of the chamber ambient air was used to simulate low-speed, cold-day flight. Most of the tests were run at sea level with the cabin occupied, but some altitude tests were run without occupants.

The tests provided answers to the questions posed. The final cabin supply air distribution configuration arrived at during the test satisfied its basic performance requirements. Since the cabin mockup was not an exact simulation of the production cabin, requirements of the system are expected to be made during further testing. However, the mockup test results are reassuring to the extent that the basic cabin area cooling approach was proved to be sound. For periods up to 6 hr, the cabin mockup was occupied while tests were conducted at high skin temperatures with a cabin supply air temperature of −50 F. Reports from the occupant were quite favorable. Cooling air inlet temperatures to simulated electronic equipment were maintained within ±10 F of cabin temperature. This is considered satisfactory. The maximum cabin cooling load was found to be very close to the estimated value, substantiating the air conditioning system design in progress. (Paper "Environmental Control on a Supersonic Bomber" was presented at SAE Golden Anniversary Aeronautic Meeting, Los Angeles, October 14, 1955. It is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

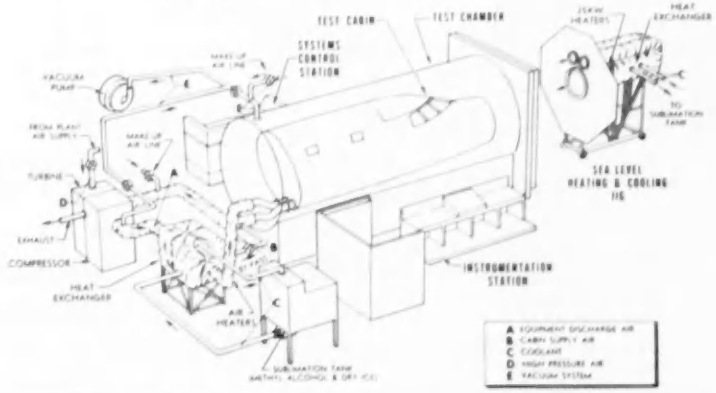

Fig. 1—Cabin mockup environmental control test set for proving effectiveness of control system under simulated flight conditions.

Trucks Could Use Manifold Braking

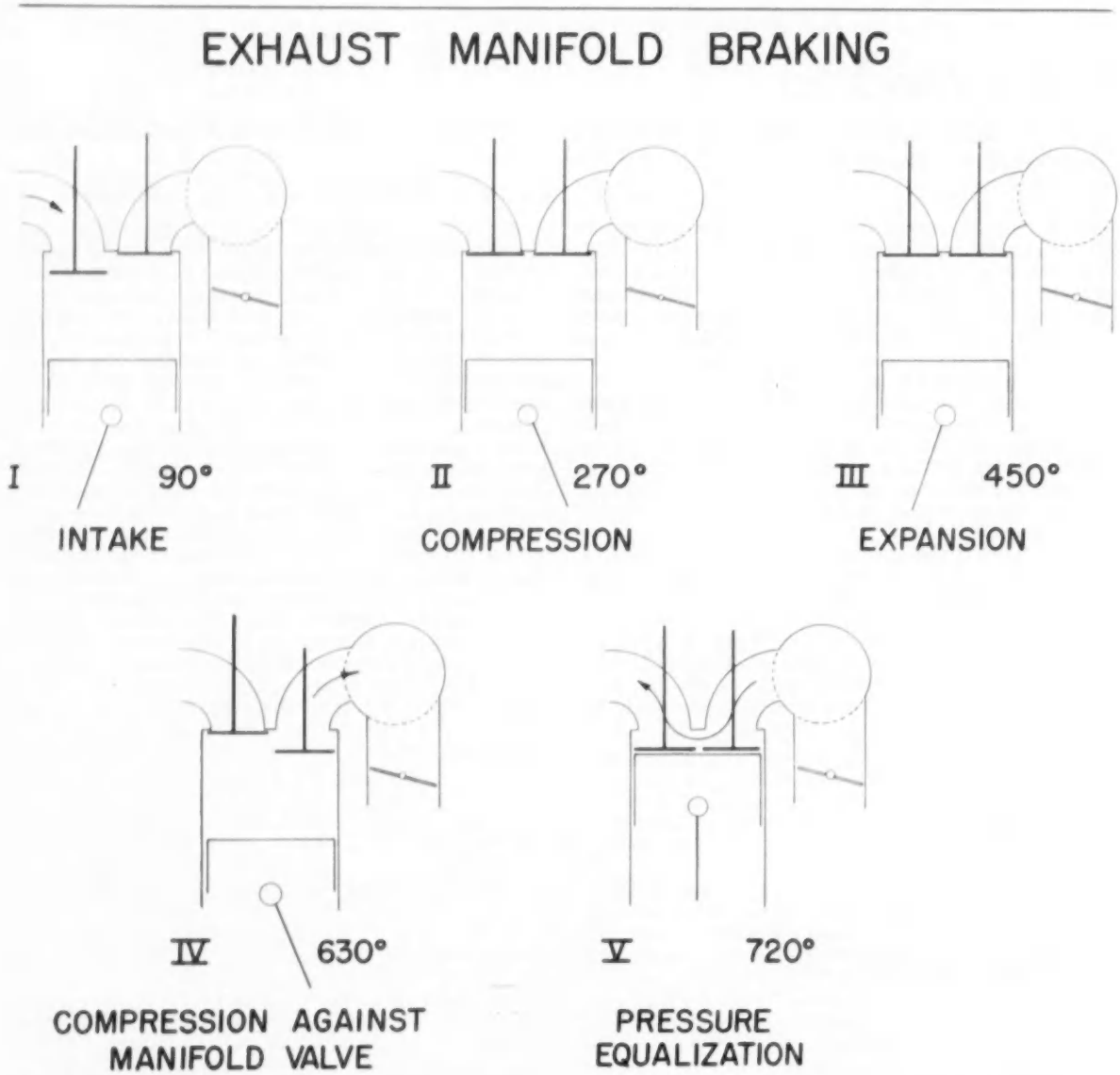

Fig. 1—In exhaust manifold braking, the intake and exhaust valve operate normally, but no fuel is drawn in with each fresh charge of intake air. During stage IV, compression against the exhaust manifold valve provides the retardation.

In Addition to Wheel Brakes

W. E. Meyer, The Pennsylvania State University

Based on paper "Manifold Braking for Heavy 'Over-the-Road' Trucks—A Review of European Practices and Experiences" presented at the SAE Golden Anniversary West Coast Meeting, Portland, Oreg. August 16, 1955.

A VEHICLE in motion is subjected to several retarding forces tending to stop it. Aside from the manual application of conventional wheel brakes, those forces arise from mechanical pumping losses, power to drive engine auxiliaries, and engine and chassis friction. The engine itself, then, is a built-in retarder, though of limited usefulness. As a consequence, different methods and means have been proposed and developed for utilizing engine retardation as a "brake" to augment retardation resulting from brake application. The object of those schemes is to relieve the brakes of the chore or maintaining a desired speed on downgrades or curves, so that the brakes proper need be applied only for rapid deceleration when stopping or before down-shifting.

Retardation versus Braking

A decelerating system—brakes or otherwise—functions by transforming mechanical energy into heat energy and dissipating the latter. Wheel brakes operate by virtue of friction between rubbing surfaces. Exhaust manifold braking, on the other hand, operates by compressing air in the cylinder against an exhaust manifold valve. While it is theoretically possible to design a retarding system to eliminate the need for wheel brakes, a serious practical difficulty arises due to the tremendous initial rate of energy dissipation and consequent large retarding apparatus required. The present wheel brake reigns supreme for deceleration above the most moderate rates.

Exhaust Manifold Braking

Of the several retarding schemes developed in the past, only exhaust manifold braking proves economically feasible. The method is inherently simple and the additional parts required are few and cost little. In this system, suitable valves simultaneously close off the exhaust manifold and the fuel supply (Fig. 1). Thus, the engine works as a compressor and increases the ordinarily parasitic retarding effect of the engine. Negative work done by the engine—an index of retardation—is represented by the shaded area in Fig. 2. A modified form of this method has gained rather wide acceptance in Europe, some countries going so far as to specify its use in certain classes of vehicles.

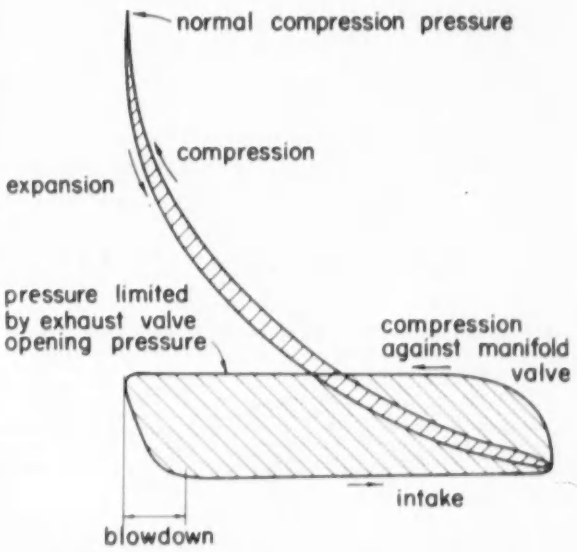

Fig. 2—Negative work is done during exhaust manifold braking. This work is sufficient to obviate wheel brake application for the low deceleration the vehicle may require while descending a grade in gear.

The effectiveness of exhaust manifold braking is illustrated in Fig. 3, which can be considered representative for both diesel and gasoline engines over a fair range of engine sizes and speeds. Note that retardation increases with speed, a highly desirable characteristic.

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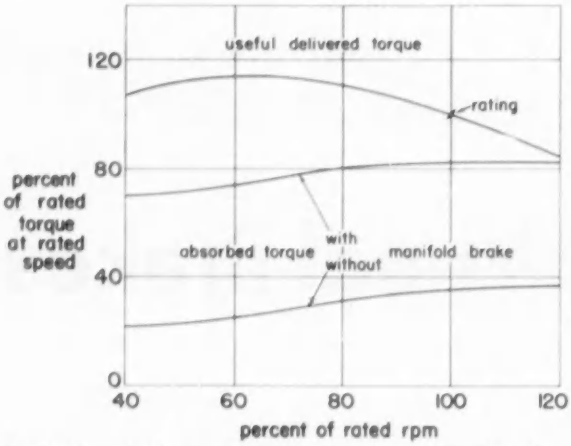

Fig. 3—The retarding torque is approximately doubled with exhaust manifold braking.

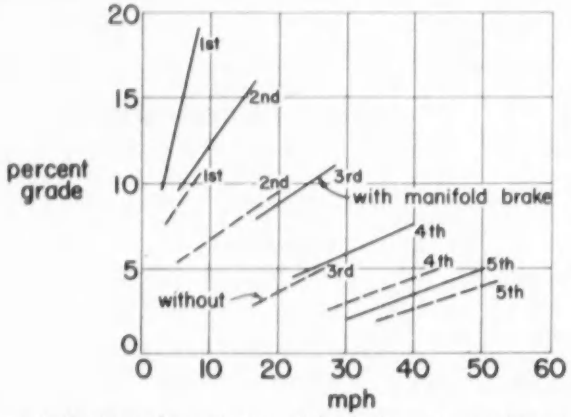

Fig. 4—Grades usually can be descended with the engine operating one gear step above that used ordinarily. This slower-speed operation reduces engine wear.

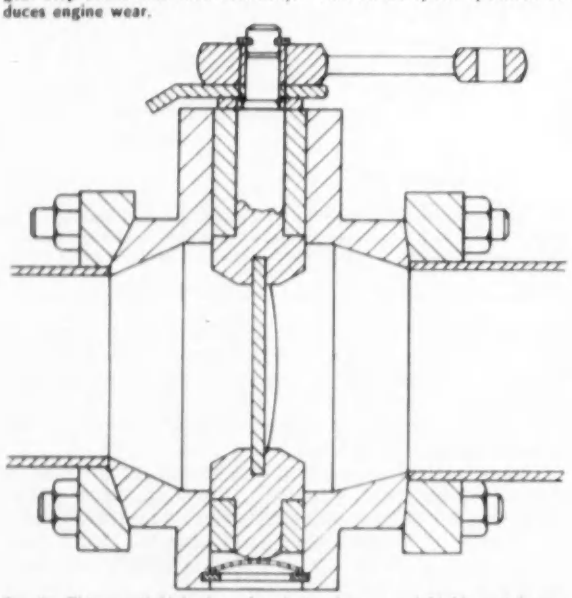

Fig. 5—This manifold brake valve design has proved highly satisfactory in operation. The increased diameter of this particular valve interposes no increased friction to gas flow in the exhaust system.

A comparison between operation with and without exhaust manifold braking is illustrated in Fig. 4.

Operation

A simple butterfly valve is located in the exhaust manifold. Experience of a valve of the type shown in Fig. 5 indicates virtually maintenance-free operation. The most suitable actuating mechanism for operating exhaust manifold and fuel cutoff valves will depend upon the service the vehicle is intended for, among other things. No definite trends have yet been established in that regard. It is desirable, however, to minimize the movements the driver must perform in its operation. The inherent smoothness with which exhaust manifold braking acts must not be encumbered by a complex operating mechanism or excess motions.

Advantages

Among the advantages possessed by exhaust manifold braking are:

1. Reduced brake lining wear, to an extent depending upon terrain and service. Data available support this statement, showing markedly reduced wear.

2. Absence of rubbing surfaces to wear and adjust.

3. Engine wear is not higher; if anything, it is decreased.

4. Measurable fuel savings accrue through its use.

5. No cylinder vacuum is produced and a minimum of oil is pumped up into the combustion chamber.

6. Torque converters are compatible with the system, provided the former dissipate heat adequately.

7. Limited information indicates no fundamental problems exist when the system is applied to supercharged four-stroke-cycle engines.

8. Driver fatigue is reduced, with a corresponding increase in safety.

Disadvantages

A few disadvantages exist, but are clearly outweighed by the advantages. The two main disadvantages today are:

1. The system cannot be applied to two-stroke-cycle engines.

2. Oil is blown out of oil-bath type air filters. This condition is more serious on engines with smaller numbers of cylinders, but can be remedied by providing sufficient volume between engine and air filter.

(Paper on which this abridgment is based is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Douglas Skywarrior Aids Navy Carrier Operation

Harry A. Nichols, Douglas Aircraft Co., Inc.

Based on paper, "Design Features of Douglas A3D Skywarrior" presented at a meeting of the Southern California Section of the SAE, Los Angeles, Nov. 8, 1954.

THE Douglas A3D Skywarrior is the largest airplane being built for carrier operation. It can carry mines, torpedoes, and bombs, including atomic weapons, long distances at high speed. The Skywarrior performance falls into the 600- to 700-mph class and it is capable of flying at 40,000 ft. A swept wing, which intersects the fuselage at the top, has two nacelles, each housing a J57 Pratt and Whitney turbojet engine. The fuselage accommodates a crew of three and incorporates an internal bombbay and tail turret. Being carrier-based and large in size, the airplane features a folding vertical tail as well as folding outer wing panels and the normal catapulting and arrested landing gear.

The three-view drawing (Fig. 1) shows the swept wing with an outline of the folding outer wing panels. Simple NACA-type slotted landing flaps, which pivot about external supports, occupy the trailing edge inboard of the folding joint. Wing spoilers are just ahead of the flaps at the outboard end. Automatic wing leading edge slats are built in three sections, one section between the folding joint and the nacelle and two sections on each outer wing panel. The nacelles are supported from the wing on pylons.

Inboard profile of the airplane (Fig. 2) shows the internal arrangement of the different systems. At the fuselage nose, the entire radome compartment houses the Navy's ASB bombing radar antenna and related electronic equipment. Immediately behind this compartment is the pressurized cockpit. Below the cockpit floor is the air conditioning equipment, the battery and oxygen equipment. Immediately behind these two compartments, and under the forward fuel tank, there is an electronics compartment and the airplane's basic power systems.

The basic power systems of hydraulic pumps and d-c and a-c electrical generators are driven from auxiliary drive units, which in turn, are turbine driven by compressed air bled from the jet engines.

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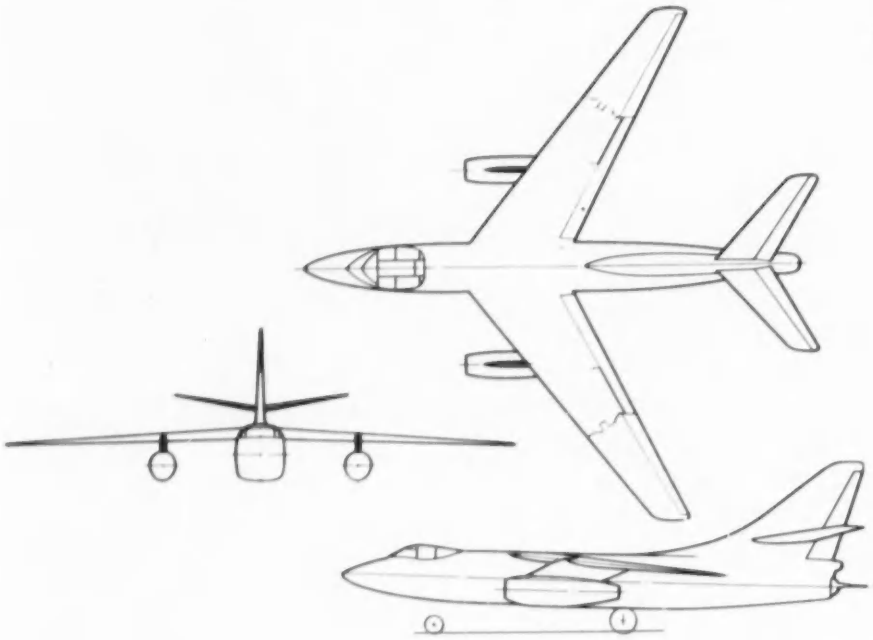


Fig. 1—Three-view drawing showing design features.

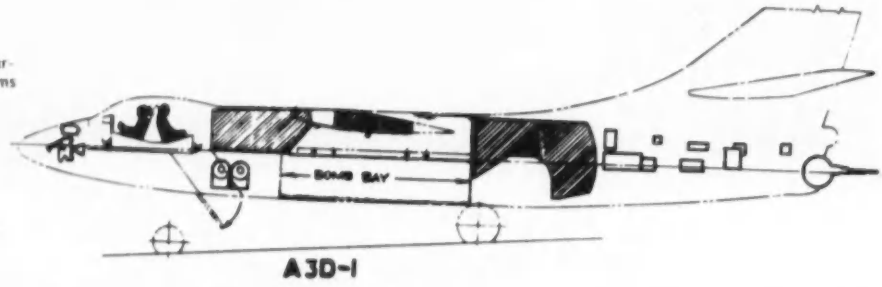


Fig. 2—Inboard profile with arrangement of internal systems outlined.

Just behind these compartments and the fuel tank is a large bombbay, behind which is another large self-sealing fuel tank and the main landing gear. In back of this fuel tank is a rather spacious compartment which houses some communications electrical equipment; however, this compartment is largely occupied by ammunition boxes, feed chutes, and electronic equipment related to the tail turret. The ball turret is Westinghouse gear, which mounts two 20-mm guns and can be controlled automatically through a frequency-modulated antenna located just above the ball turret.

History

Evolution of the airplane neatly discloses how the airplane got to be its present weight, size, and configuration. Initial Bureau of Aeronautics discussions were started in 1947, when Navy estimates for an airplane to be used for the purpose they desired, ranged all the way from 62,000 lb to 200,000 lb. As more detail studies were made, the Navy came up with a 130,000-lb airplane first. This was later trimmed to a 100,000-lb airplane. It was obvious that if the weight were to be 100,000 lb, the airplane would be limited to only the projected Forrestal class carrier. It was finally decided that the gross weight must be considerably less than 100,000 lb so that the airplane could be accommodated successfully by carriers in existence as well as the Forrestal series.

The present 70,000-lb airplane is capable of being operated successfully from all sizes of carriers, including the Essex class with certain modifications incorporated, as well as the Midway class, and, naturally, the new large Forrestal class. This size and weight were achieved by choice of the several design features which will be described later plus very careful weight control of details throughout the entire design period, even up to the present. With the excellent cooperation of the Bureau of Aeronautics a remarkable "hold the line" on changes has been maintained throughout its life.

There were a vast number of major arrangements and sizes investigated in the first year. These were the result of changing the size of the bombbay many times because of the varying needs of space requirements for the highly classified special weapons coming into use at that time. In some of these versions the tail turret was omitted, although it was included in the final design. Also, equipment carried within the airplane shell underwent many investigations of type, location, and routing. Approximately 12,500 lb could have been knocked off the gross weight if the turret had been eliminated in the initial design and smaller engines could have been used. Such is the effect of growth factor, that 1 lb added in an item requires 6.4 lb more in the form of wing and tail areas, increased powerplant, increased landing gear, in order to hold performance constant.

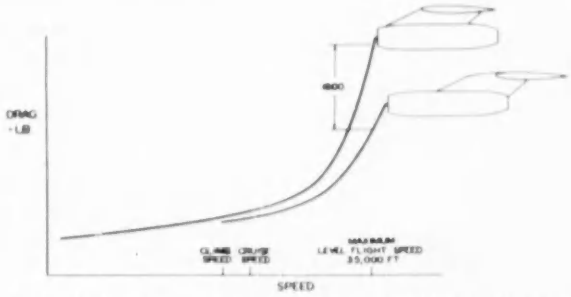


Fig. 3—Effect of fore-and-aft nacelle position on airplane performance.

Design Features

Aspect Ratio—The airplane has an aspect ratio of 6.75. This aspect ratio is higher than the average used in most Navy airplanes but not as great as that used in Air Force airplanes designed for similar purposes. It is slightly less than that initially chosen because of compromising with aerodynamic pitchup in the high-speed region, and with the wing flutter problem which, of course, largely controls wing weight.

Wing Thickness—The wing thickness tapers from 10% at the root centerline to 8¼% at the tip. This was a compromise between drag consideration, structural weight, and control characteristics.

Wing and Tail Sweep—The wing is swept back at an angle of 36 deg at the one-quarter chord line. Wind tunnel and flight data available at the time the A3D was initially conceived indicated that this amount of sweep would give satisfactory low-speed characteristics so essential for this carrier-based airplane, as well as good control at high speed with minimum high-speed drag. As usual, flutter and structural problems were also taken into account. The amount of sweep which would be employed today, would still be very close to that which was used; best information today would allow no more than 40 deg of sweep with the present 6.75 aspect ratio.

Dihedral—Wing dihedral was set at zero degrees, which again was a compromise between high- and low-speed requirements. This angle was indicated in initial design and wing tunnel tests to give the best lateral stability. Dihedral effect is a very strong characteristic in the low-speed region with swept wings. Based on subsequent flight experience, a minus one degree dihedral might be chosen today for improving carrier approach stability, however the present low-speed stability is satisfactory.

Engine Nacelle and Pylon Shape and Location—The engine nacelles are supported by pylons as low as ground clearance permits. This design was a compromise with several conflicting requirements. One was easy ground servicing of the engines, at minimum ground height, thus allowing ground crews to work without the use of platforms. This location of the engines also allows engines to be handled by standard torpedo lifting trucks with special engine support adapters without the use of any other hoisting media. Extensive wind tunnel tests showed that minimum high-speed drag could be achieved with the nacelles raised so that their top edge would be coincident with the upper surface of the wing or by moving the nacelles well forward. Moving the nacelles up would aggravate the service problem and would also interfere with the continuous single landing flap. Moving the nacelles forward on the wing would greatly improve drag, as shown in Fig. 3, but would also increase the structural weight considerably.

Miscellaneous

Escape—Fig. 2 shows that a bail-out chute allows the crew to exit in a downward and aft direction. The bottom fuselage skin door is power-operated through cartridge-fired cylinders such that the door will remain open up to airplane design limit speed. This feature provides a wind screen for the men while they exit through the bottom of the fuselage. The upper door, which forms the floor of the cockpit, is pulled down through a mechanism tied to the lower power door. The chute is completely confined with smooth walls for a safe exit.

Bombbay Arrangement—A few large stores are carried by a single shackle from the center wing, while the majority are supported from a readily removable platform located at approximately midheight in the bombbay. As an alternate, this platform can carry an additional self-sealing fuel tank to increase the airplane range. The bombs, which are supported from the platform, are carried on individual bomb ejector racks (see Fig. 2). Ejector racks were chosen in order to assure positive separation of low density stores. An antibuffet rake, which is automatically lowered when the bombbay doors are opened, was found necessary during the early bombbay buffet evaluation tests. The addition of this leading edge fence has most remarkably reduced the buffet level up to airplane high speed (Fig. 4).

Jato—The A3D is capable of performing extraordinary take-offs at full gross weight through the use of 12 large jato bottles, which are mounted on both sides of the fuselage in the area aft of the rear fuel tank. The thrust from these bottles is actually so great that a very spectacular 5-sec performance could be achieved by the airplane flying vertically. This total, jato plus engine thrust, is sufficient to allow a take-off to be made by this large airplane

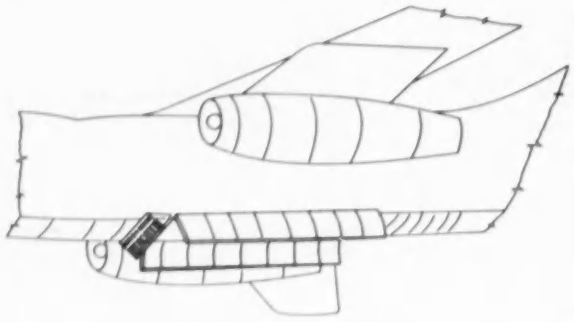


Fig. 4—Bombbay deflector.

from a carrier without the use of any catapult. The bottles are jettisonable in flight.

Fuel System—For an airplane of this size, the fuel system is surprisingly simple. As stated before, fuel is carried in two large self-sealing fuselage tanks and in two integral fuel tanks located in the inner wing panels. These wing tanks run from the side of the fuselage to the folding joint, and between the front and rear spars.

The position of the fuel tanks required the use of a center-of-gravity control device. This consists of an electrically controlled valve which either allows the fuel to flow from the forward fuel tank to the rear fuel tank or interrupts the flow. Its operation is controlled from a predetermined scheduling of tank levels and takes its operation signal from the fuel quantity probes located in the forward and aft fuel tanks. Wing fuel is transferred to the forward fuel tank at any time the pilot so elects and is actually transferred by air pressure, the source of which is engine air bleed. A carbon dioxide purging system is provided for the wing fuel tanks only.

It is intended that the pilot withhold transfer of his wing fuel until the fuel has cooled down sufficiently (and quickly) as a result of skin temperature transfer of the outside cold air. Transfer of this cold fuel reduced the temperature of the fuselage fuel and greatly reduces boil-off of the lighter constituents when the airplane has reached high altitude. Compared with separate refrigeration for reducing the fuel boil-off, this system is fully as effective and offers a large weight saving. A small 2-psi air pressure is carried on top of the fuel further to suppress fuel boil-off. This overall problem has recently been lessened by the advent of JP-4 fuel.

Structure—The airplane structural arrangement is quite simple, straightforward, and generally conventional The entire airplane structure is constructed mainly of aluminum-alloy materials embodying a high percentage of 75ST material. A combination of longitudinal and transverse skin stiffeners are used depending on the location of miscellaneous cutouts. Long heavy keel members run from the nose to the tail of the airplane and these keel members pick up catapult fittings as well as the arresting gear fitting strength members at the aft end. The wing structure is composed of two spars plus very heavy skin between spars. The wing torsional strength was determined not from bending loads, but from flutter requirements with a result that the spar-to-spar wing skins are made $\frac{3}{8}$-in. thick and this thickness runs all the way from the airplane centerline to approximately one-quarter of the way into the outer wing panels. In order to effect a further weight saving, the large lug-like fittings, which are required at the folding joint to accommodate the hinge and locking pins, are made integral with the upper and lower wing spar caps. Stepped extrusions are utilized to facilitate the manufacture of this type of spar cap.

Controls—All three primary controls systems are hydraulically power-operated. The A3D airplane is designed with rudder and elevator boost ratios sufficiently low to allow satisfactory control on manual control alone. Inasmuch as a low boost ratio in the aileron system was not possible, dual aileron power systems, completely independent of one another, have been incorporated. This system, when normally operating with the dual power source, will give the equivalent of a 40/1 boost ratio although it is actually irreversible. When one of the independent power systems is inoperative, the power output is reduced by one-half which still provides a very satisfactory control. In addition, a manual system with a 2 to 1 mechanical advantage is provided and it has been demonstrated by field landings that landing control is satisfactory. Questionable carrier landing safety would exist due to the higher required rate of roll to counteract the turbulent air behind a carrier. Longitudinal trim is effected through a pilot-adjustable stabilizer which is actuated by 2-speed, a-c and d-c, electrical motors. Independent emergency systems are also provided for the landing gear and landing flaps. Their normal operating systems are hydraulic and the emergency systems are completely pneumatic.

Wing Spoilers—Wing spoilers which approximately double the rate of roll produced by the ailerons alone, are located on the upper surface of the wing just forward of the wing flaps and at the outboard end of the inner wing panels. These spoilers, which operate independently on one side or the other, sense their required motion from the aileron controls. The spoiler control system, is independent of the aileron boost system and does not cause any additional feedback of load into the pilot's control column. The spoilers do not operate when the ailerons are on "manual." The large gain in rate of roll due to the spoilers is achieved in the high-speed region because they cause no detrimental wing twisting which will result in zero rolling effect at a certain speed, when ailerons are used alone.

Speed Brakes—These are large hydraulically operated hinged flaps located on either side of the aft fuselage. They are pilot controlled and may either be fully opened or fully closed since this airplane would not normally be flown in formation, thus requiring partial opening for minute speed adjustment.

Air Force Version—As a measure of the apparent success of this airplane, the Air Force contracted the Tactical Bomber B-66 on the basis of using the A3D design in lieu of other competitive designs.

(Paper on which this abridgment is based is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Control Techniques Cut Costs

F. Mencik, Curtiss-Wright Corp.

Based on secretary's report of panel on Getting Maximum Results from a Cost Reduction Program held as part of the SAE Aeronautic Production Forum, New York, April 21, 1955

INCREASINGLY important in raising operating efficiencies and lowering costs of manufacturing are:

1. Suggestion systems
2. Standard cost analysis
3. Direct and indirect time studies
4. Proper machine utilization

Suggestion Systems

A suggestion system, to be successful, must attract and maintain the interest of the employee. Extensive publicity and cash awards are the two most common methods of doing it. In addition employee interest is maintained by rapid processing of suggestions and by supervisors well-versed in Suggestion Committee procedure.

The success of the entire program depends on employee participation—which in turn, depends on the publicity and on ingenious promotional devices. One large aircraft firm, for example, gave away a large color print of its latest plane to anyone who submitted an acceptable suggestion during a specific month. This inexpensive inducement resulted in a 500% increase in suggestions for that month.

The selection of a "Man-of-the-Month" has also been used to considerable advantage. The individual submitting the most valuable suggestion each month is honored and employee interest is greatly stimulated. A picture of the award ceremony is displayed throughout the plant, with the name of the employee and the dollar value of the award prominently indicated.

A first step in developing any suggestion system is to determine an appropriate money award. Most systems pay a percentage of annual savings, with a limitation set on the maximum award. An added inducement may be provided by having the company pay any taxes which might be associated with the employee's award.

Processing ideas simply and rapidly is of basic importance, too. Excessive time discourages the employee from submitting additional ideas. *All* suggestions should be returned with an explanation of why the idea was accepted or rejected. Whenever a suggestion is rejected, it is important to convince the individual that every effort was made to utilize the idea and to indicate the factors which prevented its adoption.

Closely related to the processing method is need for a thorough understanding by supervisors. The system is a logical subject for discussion in any supervision training program. One large firm has several supervisors attend the Suggestion Committee meetings each week, to give them a first-hand knowledge of the system's operation. This approach enables supervisors to answer accurately employees' questions about the system.

Savings resulting from a suggestion system can and should be of major import in the constant fight to lower costs. A suggestion system can also help in labor relations. It is one way to demonstrate to

The material on cost reduction contained in this article is based on a panel discussion by the following experts:

Panel Leader:

J. V. Miccio,
Wright Aeronautical Division,
Curtiss-Wright Corp.

Panel Secretary:

F. Mencik,
Wright Aeronautical Division,
Curtiss-Wright Corp.

Panel Members:

G. E. Fouch,
General Electric Co.

R. S. Kennerson,
Thompson Products, Inc.

P. F. Weber,
Kollsman Instrument Co.

A. Von Gertz,
Republic Aviation Corp.

all employees the common interest in producing better products at less cost.

Standard Cost Analysis

Maximum returns result from standard cost systems when foremen on the line receive data pertinent to their respective operating units. Cost and efficiency data should be provided on a frequent and current basis. The foreman then has the information for controlling and improving performance.

Measurements at the lowest level of supervision eliminate guesswork and permit correction of high or unexplained costs.

Standards should be developed for each measurable and controllable cost. The standard represents the best attainable performance under good practical operating conditions.

Goals are established and performance reported regularly for each organizational unit. These reports enable management to spot variances from the standard. A study is made of such variances and corrective action taken. For example, excessive labor costs may require a revision of methods or, quite possibly, induce more mechanization.

Direct and Indirect Time Studies

Clerical costs can be reduced by:

1. Labor saving equipment
2. Paperwork coordinators
3. Job standards

In clerical operations, application of the latest labor saving equipment has proven beneficial wherever established.

The purpose of paperwork coordinators is to eliminate as much paperwork as possible. Special attention is given to reports. They are to be kept to a minimum but must be so effectively designed that any valuable control information is provided on a current basis.

Clerical jobs should be measured and standards set. This requires the definition of each individual's job and an estimate of his work load. The responsibilities may be divided into:

1. Things that must be done
2. Special projects
3. The balance of regular work

Engineering work requires complete objectivity in achieving minimum costs. An industrial engineering group to review designs is one way to cut costs. Coordinating with the designer, this group can arrive at a part design which may be manufactured most economically.

Once all individual jobs and activities are time studied, it will be possible to predetermine manpower requirements. This then provides the same effective control measurements as are now available to management for direct labor. With this data, cost reduction projects can be organized to effect increased output per employee.

Proper Machine Utilization

Maximum utilization of machines involves efficient layout, decision on the number of shifts to be operated, and when to use single-purpose and when multipurpose tools. The results of maximum utilization, properly measured, give management an important cost control device.

What is "efficient layout" in a particular factory, depends, of course, on the requirements of the particular operation. In some cases, for example, a generic type layout (which groups machines together by types) will be best. In others, a progressive production type (where the machines are arranged to handle specific parts) should be chosen. Sometimes, a combination of the two will be most effective.

One-, two-, and three-shift operation each has its special advantages. Theoretically, three-shift operation provides the maximum utilization of the machines. It is also the most effective method of combating obsolescence costs. However, this type of operation is not always practical. This is due to such factors as the nature of the business, seasonal and cyclical demand influences, and the rapidity of technological advances in the industry.

Singleshift operation, on the other hand is profitable under most circumstances, because it:

- Eliminates shift differential pay
- Gives more effective control
- Provides constantly availability of service departments

Selection of tool types also is vital to maximum utilization. The problem with single-purpose tools, for example, is this:

A particular machine will be used only 10% of

the available time, yet the precision required will dictate its use.

Then, certain standard tools, with special fixtures or attachments that remain on the machine change its classification to a special machine tool. Cost reduction and control is accomplished by determining where such excess machine capacity exists. Steps can then be taken to bring in parts from vendors which will utilize this surplus capacity.

To get the proper measurement of utilization required to make results is not always easy. The actual power rating of all machines or specific groups of machines may be related to the electrical energy actually consumed. If the rating of machines is considerably in excess of the energy consumed by these machines, it reflects an over-powered condition. However, this finding must be tempered with the requirements for light cuts, special machine application, and other factors which would lower the amount of electricity required.

It allows the use of most efficient machines and disposition of old or excess machines. This assures that capital investment in machines is kept to a minimum and that capital invested is in machinery which provides the maximum rate of return.

(The report on which this article is based is available in full in multilith form together with reports of the six other panel sessions of the 1955 SAE Aeronautic Production Forum. This publication, SP-311, can be obtained from SAE Special Publications Department. Price: $1.50 to members, $3.00 to nonmembers.)

Air Pollution . . .

. . . reduces the amount of solar energy reaching the earth. Greater carbon dioxide concentration increases absorption of terrestrial radiation to warm the earth. Which of these conflicting effects will control?

Based on paper by **Dale H. Hutchison,** Stanford Research Institute

AIR pollution is a world-wide problem. If sufficient particulate material is carried into the atmosphere, a gradual drop in temperature can occur which can have a definite effect on man, plants, and animals.

No data are available to determine the reduction in solar energy in the Los Angeles area where smog is a serious problem. In Boston, however, the solar radiation reaching the surface during the period October through March (Boston's air pollution period) was 18% less than that at nearby Blue Hill Observatory. During one intense smog, the solar radiation in Boston was reduced 90%.

Marked year to year fluctuations in the intensity of solar radiation have been found by Dr. H. H. Kimball of the U. S. Weather Bureau. Most of the sharp decreases are attributed to the eruption of volcanoes, there being a definite correlation between violent eruptions and cold years. Man has not yet been able to generate an energy release equivalent to the eruption of volcanoes, nor has he been able to devise a method of getting so much dust into the atmosphere, but unfortunately he is learning and becoming more efficient at producing dust.

We are contributing large quantities of carbon dioxide to the atmosphere each year, about 3% per year at the present rate of fossil fuel use. This increase in concentration can absorb terrestrial radiation increasingly and thus cause a gradual warming of the earth's surface. In addition, other factors being equal (such as temperature and available water), the increased carbon dioxide concentration can cause increased photosynthesis of plants. There is more than ample light energy available for photosynthesis, and the optimum concentration is about five times that available in the atmosphere.

There is evidence of a recent, gradual warming of the climate of the northern hemisphere. Five centuries of records for the freezing date of Lake Suwa in Japan indicate definitely that freezing has occurred later during the last 250 years, which is valid evidence of gradual warming. In addition, there is considerable evidence of the recession of glaciers in the northern hemisphere, which is another indication of warming.

It has been stated that the combustion of fossil fuels could be responsible for a 10% increase of carbon dioxide in the atmosphere if none were taken up by the sea. Estimates by Calendar, L. Kaplan, and Plass suggest that this increase could account for the climatic change which has been observed. The carbon dioxide contributed by the yearly combustion of fossil fuels is greater than one-third of the annual assimilation by terrestrial plants.

Total energy consumption for the world for 1952 indicates that 96.9% of the energy from fossil fuels is consumed in the northern hemisphere. The carbon dioxide concentration increase in the northern hemisphere could be doubled if there were no mass transport from the northern to the southern hemisphere. Data now available to estimate this transport are insufficient. (Paper "Meteorology and Air Pollution" was presented at SAE Seminar on Fuels and Lubricants, Los Angeles, April 6, 1955. It is available from SAE Special Publications Department as part of SP-139 along with 5 other papers presented at this Seminar. Price: $1.75 to members, $3.50 to nonmembers.)

High Pressures Present Problems in Design of

Liquid Springs

Paul H. Taylor, Wales-Strippit Corp. and Taylor Development Co.

Based on paper "Liquid Springs in Vehicle Suspensions" presented at SAE Golden Anniversary Annual Meeting, Detroit, Jan. 14, 1955.

LIQUID springs will be serious contenders with the conventional types used in vehicle suspensions when certain problems—particularly those relating to high pressures—are more fully solved. Chief among these challenges are:

- Development of liquids capable of greater compressibility.
- Sealing.
- High-pressure chambers.
- Mass-production problems.

Compressibility

A 14–15% compressibility will be needed for direct-action liquid springs without levering even on vehicles of medium weight. (This compares with the 12% for present silicones at 20,000 psi.)

The greater compressibility is needed to provide the desired efficiency and so the piston shaft can be made in a practical size. Otherwise, levering is necessary to gear the spring up—so to speak—to a higher spring rate. (See Fig. 1.)

Since the volume encompassed by a liquid spring at any given pressure is proportional to the total volume of liquid displaced by the piston, a 6% compressible liquid such as mineral oil has twice the volume of a 12% compressible liquid; therefore, it is obvious that the key to the resilience per unit volume is directly related to the compressibilities. From factors at hand, it appears that the 12% now available in straight compressible liquids provides a liquid spring of 2000-lb-per-in. spring rate, with an applied design stress of 70,000 psi (140,000-psi ultimate).

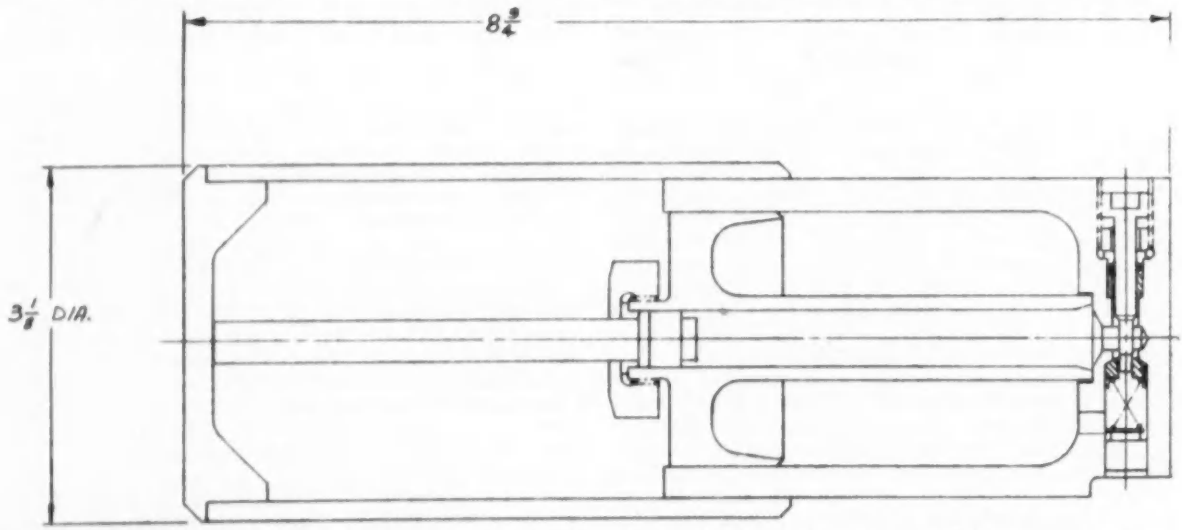


Fig. 1—Drawing of proposed liquid spring for light vehicle. One of problems involved in designing these springs is attaining proper sealing, because of high pressures needed.

for Vehicles

Another desirable feature would be for the material to have a minimum expansion or contraction under temperature changes, for the value of the spring could be destroyed by thermal shrinkage.

The compressible material should also provide lubrication to the seal. It should, therefore, have a fairly good body of around 100 centistokes, or about SAE 30, in order to provide desirable characteristics for this purpose. It should also be thin enough to be poured through a small filler opening, yet viscous enough to seal. The liquid should also have shear stability to avoid breakdown. This latter is particularly true when dampening means are used in the system.

Sealing

Highly compressible liquids so far developed are not good lubricants at the extremely high pressures used in liquid springs. Thus, it is important that any sealing material be carefully backed up by a structural member. Metal riding on metal galls and seizes in less than one operation. This is particularly true with the silicones, which thus far have proved most desirable in liquid springs. With compressed liquids, it is, therefore, important to isolate all metallic contacts with suitable bearing materials.

To have an efficient liquid spring, leakage must be held to zero. This means intimate interference between the seal, the bore in which it operates, or interference fit on a seal of ½-in. diameter from 0.001 to 0.002 in. Obviously, unless a seal material is compatible with the bore and the compressible material, heat will be generated and galling and seizing will occur. This accounts for the failure of metallic contacts in the presence of the compressible material.

Early work was discouraging because of the repeated failures with one single stroke on a spring that had been built over a period of months at a substantial cost.

Since the seal cannot be completely backed up by the structural steel piston member, because of galling and seizing, a structural elastic member must be used. Thus, a material is needed that is elastic, structural, and yet a good enough bearing

What's a Liquid Spring?

THE compressibility of fluids under pressure provides the resilient action that makes the liquid spring work.

The fluid must be chosen with extreme care, for only a few liquids—such as the silicones and the fluorocarbons—have compressibilities high enough to do the job. Moreover, the operating pressure of the spring must be high to attain sufficient compressibility, even with these fluids.

Thanks to such high pressures and the enclosure of the liquid in one continuous volume, the liquid spring occupies only about one-third the space of a comparable steel coil spring.

Unlike the fixed loads of mechanical springs, the forces of liquid springs can be varied by changing the type or volume of the fluid. In addition, spring forces can be varied in some models by turning a mechanical force adjuster.

Liquid springs are particularly useful for high-force, short-stroke (high-spring-rate) applications, such as in metal fabricating dies, heavy-duty perforating equipment, metal working and machine tools, plastic injection dies, and resiliently supported numbering stamps in blanking dies, where travel of the press ram cannot be accurately determined.

So far, however, only experimental applications have been made to vehicle suspensions. These include several designs built for heavy trucks. Plans are also under way to adapt the liquid spring to the suspension systems of lighter vehicles, including passenger cars.

It is claimed that the liquid spring can allow commercial vehicles to carry greater payload with more springing and less damage to the payload because they provide efficient shock dampening and reduce the size of the spring package.

Because of the high pressures required by these springs, however, liquid springs present interesting design and manufacturing problems that are only now in the process of being solved. What is being done toward solving some of these problems is related in this article.

material in the presence of these compressible liquids when operating on steel. Nylon is the most satisfactory material investigated so far. Teflons, on the other hand, extrude like toothpaste through the gap left in the cylinder. Certain grades of nylon work very well in the presence of silicone while operating against steel. To assure enough elastic engagement of the wall, it is essential that the seal be fairly long. There is more structural than elastic quality in nylon, so the seal must be guided accurately in the bore to prevent side loads.

Seal life has been found proportional to seal travel and internal pressures. From this point of view, some form of levering becomes desirable. Moreover, male seals are preferable to female seals, in that they exhibit longer life.

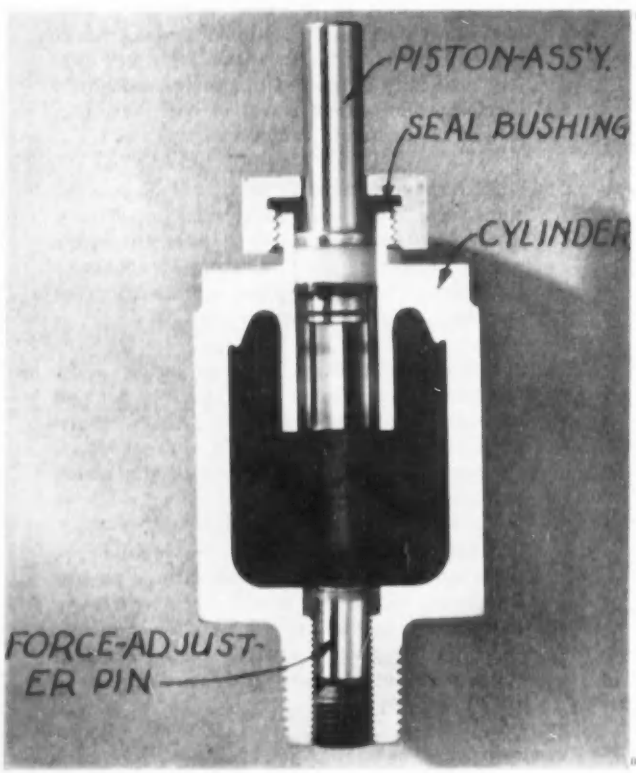
Seal travel of 250,000 linear in. at zero leakage is now realized at 20,000 psi. At slightly less pressure, this figure increases rapidly. If periodic service is possible, the slight dynamic leakage after this period is of no consequence. Central replenishing and liquid control systems are also possible for extremely long service life. Internal pressures of 16,000 psi have provided zero leakage, seal life up to 750,000 linear in. of seal travel.

High-Pressure Chambers

The design of efficient high-pressure chambers is in itself an art. To be useful in a spring, the chamber must withstand pressures of 1000–20,000 psi each spring cycle. For example, a $2\frac{3}{4}$-in. diameter production spring has a 0.006-in. deflection in the outer wall each cycle. This actually is a compound stress problem, more serious than that on some of the conventional springs. Spherical chambers could be utilized but space and production prevent this. Long cylinders are more adaptable to manufacturing processes, but this puts the middle of the long cylinder in simultaneous hoop tension and bending. For an efficient design it is necessary to use the triple alloys, such as SAE 4340 or 8630, having ultimate stress levels at Rockwell 30 of 140,000 psi, then design for a maximum pressure of 20,000 psi at 70,000-psi design stress in the springs. In vehicle suspensions this level should be dropped to 50,000–60,000-psi design stress with the same ultimates.

The suggestion may be made, why not go to 200,000-psi ultimate and use a design stress of 120,000 psi at 20,000-psi pressure. Unfortunately, safety will not permit this in the spring. At around Rockwell 50, any failure of the spring would be explosive, with fragmentation occurring simultaneously with great release of energy (Fig. 2). At Rockwell 30, failure occurs by a small split in the chamber wall, allowing liquid to leak out without explosive fragmentation. Design of the cylinder should avoid any abrupt change of section and tool mark notch effect, as they induce failure just as in any spring. In addition, all abrupt transitions from the round to the flat should be avoided, substantial radius and builtup sections should be used.

Cyclic failure occurs in a liquid spring as in a mechanical spring, and depends upon the forces to which it is subjected. A spring cylinder operating under an applied design load of 70,000 psi (140,000-



Liquid spring with main parts labeled. Note that this model, which is used in the machine tool field, is provided with mechanical force adjuster.

psi ultimate) with an internal liquid pressure of 20,000 psi lasts about 400,000 cycles before cyclic failure occurs, generally by a small crack in the wall. Reduction of the pressure to, say, 17,000 psi in the liquid and 50,000 psi in the steel wall, with the same ultimate, will, however, mean that the liquid springs will last millions of cycles before cyclic failure.

The rear spring in one of our popular passenger cars is said to fail after 400,000 full cycles. Thus, it appears that liquid springs are within the range in which present passenger vehicle springs fail. It is worthy of note that, if the spring is heavily loaded, as, say, on a fully loaded commercial vehicle, failure does not occur as early.

Mass-Production Problems

The difficulty seems to be to convince personnel that extraordinary quality control must be maintained. Tool marks and other surface blemishes in the wall of the spring are the source of possible failure, and must be prevented or eliminated in the spring. Finishes must be 2–3 Mu in the critical bore in which the seal operates.

(Paper on which this abridgment is based is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

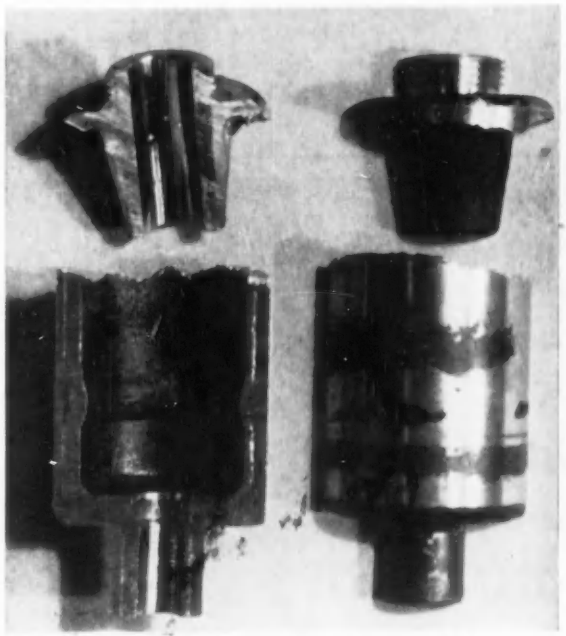


Fig. 2—Explosive failure of precision cast cylinder.

Automation . . .

. . . can be reached through step-by-step process. Electrical controls and drives will play more and more important roles.

Based on secretary's report by **A. E. Wiles,** General Electric Co.

UNIT machines, equipped with transfer devices, fit into the automation picture when one or more of three conditions exist. The first of these conditions relates to capital investment. When machinery replacement funds are inadequate for purchase of an entirely special multi-station line, consideration should be given to periodic purchase of individual units with transfer devices. These eventually can be tied together to form a complete automation unit.

The second condition exists when there is lack of continuous production on a single part, due to variation in the work pieces. Unless pieces are very similar, it is quite impractical to design a multi-station machine to handle them efficiently.

When the nature of the product is such that the various operations do not lend themselves to a multi-station machine, we have the third condition. An example of such a product would be a motor rotor where the operations are very dissimilar.

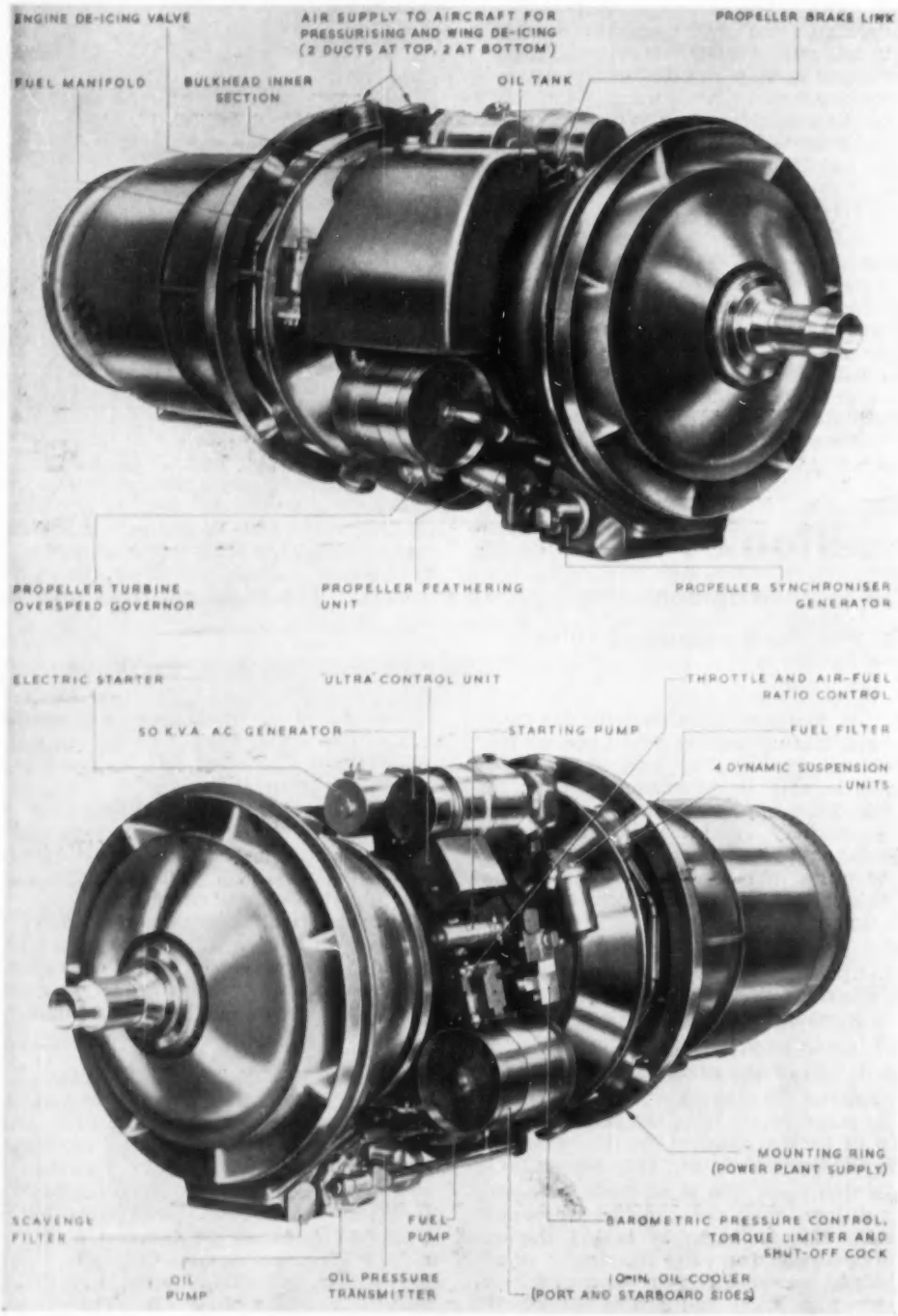
The production man who must work with these limiting conditions need not consider automation beyond reach. He can begin by taking the most troublesome operation from the standpoint of cost, inaccuracies and operator fatigue, and purchase a single unit machine, with standard or special automation features, to handle it. That serves very well when cost is an item. The machine can be designed to handle a variety of parts, and lend itself to many operations, when the associated operations are dissimilar. When the machine has proved its worth, others can be acquired and operated together with automatic transfer devices.

In the future, we can expect to see an increase in the use of electro-magnetic feed drives for individual machining stations. This function can be performed very easily with a simple low-cost electric adjustable speed drive.

The electrical engineer must select his components and develop circuits to obtain maximum reliability. New designs of relays, contactors, and limit switches have increased the operating life of control units substantially. With automation, the best electrical components and installation will be the least expensive in the long run.

(This article is based on the secretary's report of panel on "Machine Tools In Automation" held at the SAE Golden Anniversary Production Meeting and Forum, Cincinnati, March 14, 1955. Leader of the Panel was P. H. Alspach, General Electric Co.; secretary was A. E. Wiles, General Electric Co. Panel members were: J. B. Cunningham, Wilson Automation Co.; J. M. Delfs, General Electric Co.; J. Q. Holmes, General Motors Corp.; L. Perry, NATCO.; W. R. Slattery, Ford Motor Co.; F. R. Swanson, Sundstrand Machine Tool Co. This report together with seven other panel reports are available as SP-310 from SAE Special Publications Dept. Price: $1.50 to members, $3.00 to nonmembers.)

British B.E. 25 Is a



This mockup of the B.E. 25 shows disposition of the accessories.

"Supercharged" Turboprop

S. G. Hooker, Director, Engine Division, The Bristol Airplane Co., Ltd.

Based on paper "The Supercharged Turboprop" presented at SAE Golden Anniversary Aeronautic Meeting, New York, April 18, 1955.

BY adding a compressor to obtain a supercharging effect, the Bristol Airplane Co. has produced a transport engine, the B.E. 25, (shown at left) featuring:

1. High power from low weight and volume.
2. Low specific fuel consumption and high efficiency.
3. Take-off power independent of airport altitude and air temperature.
4. A two-stage helical reduction gear.
5. All-steel construction.
6. High efficiency when installed.

The B.E. 25 is intended to replace the Proteus 755 in such transports as the Britannia.

Fig. 1 illustrates the B.E. 25 engine. The high-pressure compressor, the combustion chamber, and the high-pressure turbine form a unit similar to the usual single-spool jet engine. Its exhaust drives a low-pressure turbine, which powers the low-pressure compressor and—through gears—the propulsion propeller.

Engine exhaust drives the three-stage low-pres-

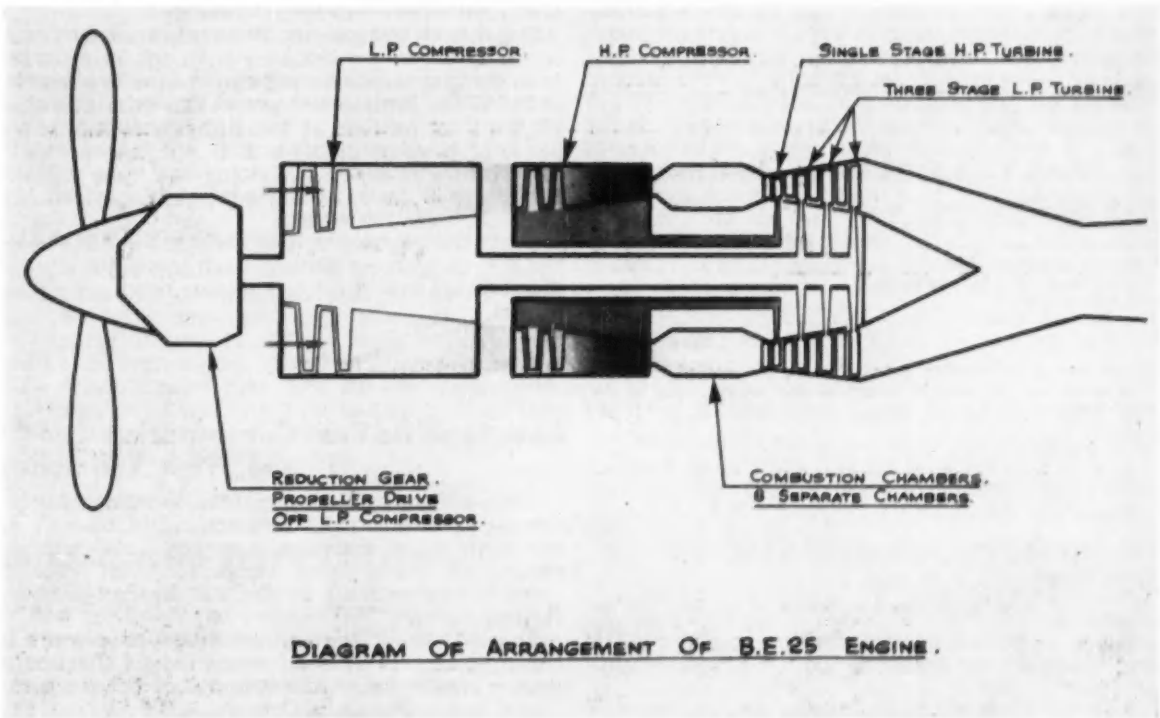


Fig. 1—Path of the working fluid is: low-pressure compressor, high-pressure compressor, burners, single-stage high-pressure turbine, low-pressure turbine. Low-pressure compressor and turbine are on one shaft, which revolves inside the shaft connecting the high-pressure compressor and turbine.

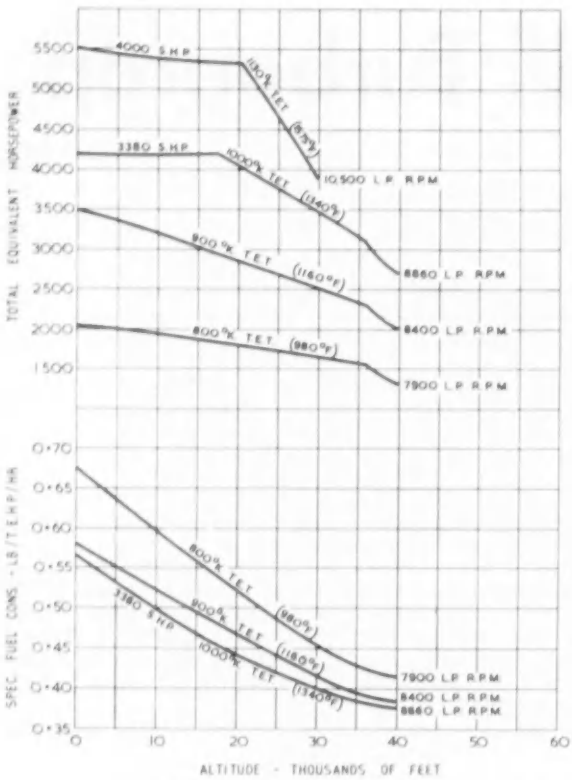


Fig. 2—Power and fuel consumption at 220 mph vary thus with altitude. Values are calculated on the basis of no intake loss and no power take-off.

Table 1—B.E. 25 Weight Installed

Engine (Dry), Including Oil Tank, Coolers, and Dynafocal Units	3200 lb
Electrical Systems	248 lb
Cowlings and Mountings	422 lb
Cooling Ducts, Fire Extinguishers, and Miscellaneous	220 lb
Propeller and Spinner	870 lb
Total	4960 lb

Note—The above weights do not involve the use of titanium. This metal will be used to lessen engine weight later in the development of the B.E. 25.

sure turbine. This turbine powers the low-pressure compressor.

Three controls limit the output of the engine. One is a fuel throttle connected to the high pressure system. A second control governs propeller pitch and therefore the speed of the low-pressure compressor.

The third control is the torque limiter. Torque is transmitted through the compound reduction gear. This torque is balanced on the final gear by a piston backed up with oil. The oil pressure (transmitted torque) is then balanced against engine burner pressure. If the transmitted torque exceeds its limiting or rated value, a valve moves to reduce fuel flow. The engine is throttled and the torque is limited. Thus the reduction gear can never be over-loaded.

High Power from Low Weight and Volume

Because the density of air lessens as altitude increases, a single-compressor turboprop capable of delivering 8000 hp at sea level can deliver only 3500 hp at 30,000 ft. A heavy prop and reduction gear designed for 8000 hp have had to be used, therefore, on a 3500 hp engine.

The supercharged turboprop operates almost constantly at 4000 hp. The two compressors readily replenish any turbine air deficiency due to altitude. In comparison with the conventional turboprop, the B.E. 25 take-off power has been decreased but the cruising power has been increased. Significant weight savings result from the smaller prop and reduction gear required for the new engine, as can be seen from Table 1.

Fig. 2 illustrates B.E. 25 engine performance. The "10,500 low-pressure rpm" curve corresponds to maximum or take-off power from the prop. In addition, a jet thrust of 2400 lb assists take-off.

Up to 17,500 ft the engine runs at 8860 rpm, which corresponds to 3380 hp from the prop. The jet contributes the equivalent of another 770 hp. Thus 4150 total equivalent hp is available.

The B.E. 25 will give the Britannia transport considerably better performance than the Proteus 755 (a single-compressor turboprop) does. For example, at 30,000 the Proteus will propel the Britannia with 130,000 lb of payload at 360 mph, giving 0.09 miles per lb of fuel. With the B.E. 25, the transport will fly 407 mph at 28,000 ft, getting the same mileage per pound of fuel. At the same time, payload can be increased to 150,000 lb.

Or, if the payload is held constant at 130,000 lb, the B.E. 25-powered Brittania can travel 400 mph at about 33,000 ft and get 0.11 statute miles per pound of fuel.

Low Specific Fuel Consumption and High Efficiency

With turboprops, specific fuel consumption decreases as turbine inlet temperature increases. As the temperature increases, however, metal fatigues faster. A compromise temperature of 1340 F (1000 K) was selected for the B.E. 25 high-pressure turbine.

Above 17,500 ft the turbine inlet temperature is constant at 1340 F. Below this height the torque limiter restricts power, and therefore the temperature decreases as altitude drops.

At 1340 F (1000 K) with a compression ratio of 10/1, a consumption of 0.37 lb fuel per hp-hr is obtained at 25,000 ft and 300 mph. A higher compres-

sion ratio would be an advantage. The fuel consumption of a 10/1 ratio turboprop is lower than that of most piston engines, however. This ratio is easily obtained on the B.E. 25.

At 30,000 ft and 220 mph air speed the B.E. 25 develops 3500 total equivalent hp. Compare this power with the 2000 hp available from a more conventional turboprop, the Proteus, under the same conditions. The B.E. 25 specific fuel consumption is 0.40 lb per total equivalent hp-hr as against 0.50 for the Proteus.

At speeds greater than 220 mph specific fuel consumptions are lower. This is because of the increase in jet thrust at high speeds.

The compressors remain just about 90% efficient regardless of compression ratio. This leads to great flexibility and stability in engine operation.

All-Steel Construction

Both B.E. 25 compressors are constructed entirely of steel. Nuts, bolts, and chunks of ice have passed through the steel compressors with no catastrophic failures. A steel compressor which absorbed a steel pin, for example, suffered only trivial damage. In this instance, the only result was a drop of 300 hp. Aluminum-bladed compressors absorbing similar objects have sustained extensive damage.

Combustion chamber design in the B.E. 25 is based on that used for the Proteus. Combustion chambers have been run for 500 hr with absolutely no servicing.

The turbine design is also based on that used for the Proteus. Shrouded blades are used on the first three wheels and open blades on the fourth (last) wheel.

Turbine wheels tested over 1200 hr at 170 F over cruising temperature without reblading or servicing of any kind still look good.

Take-off Power

Fig. 3 illustrates the effect of geographical location on take-off powers of the B.E. 25 and the Proteus. By using water-methanol injection, the inlet air temperature can be reduced and the power increased for each engine. Even so, the loss in power at La Paz is greater than 30% for the single-spool turboprop, as compared with a trifling 16% for the B.E. 25. The power drop is due mostly to the decrease in jet thrust as altitude increases.

Installation On Britannia Transport

A four-blade 16-ft diameter De Havilland propeller has been selected for the B.E. 25. Maximum prop speed on take-off is 945 rpm, corresponding to 10,500 rpm of the low-pressure compressor.

When cruising, the prop spins at 800 rpm, corresponding to 8,860 low-pressure compressor rpm. Noise is reduced due to the prop tip speed of about 700 fps. A free-air prop efficiency of 86% has been calculated at 400 mph true air speed.

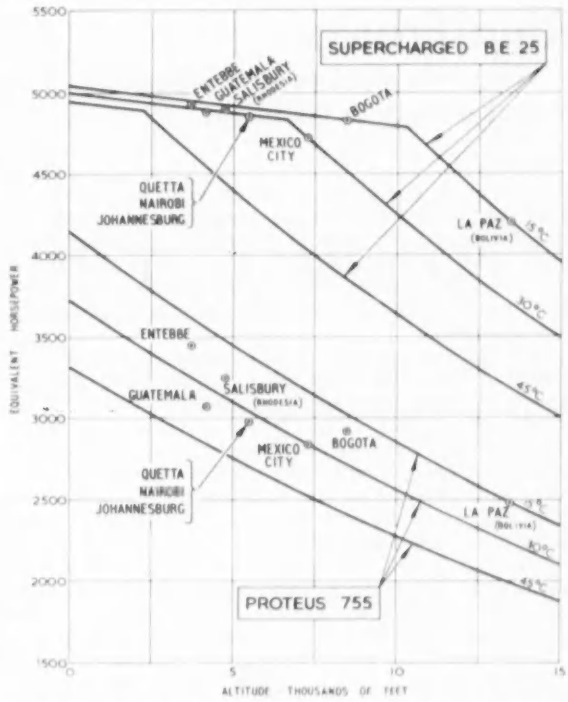


Fig. 3—The B.E. 25 offers considerably more power for take-off than does the Proteus, at all altitudes.

Besides propelling the airplane, the B.E. 25 drives a 47-kva generator and maintains sea-level pressure in the cabin up to 35,000 ft. The new engine also provides air both for wing de-icing and for operating an ejector to cool the rectifiers. Since the air is supplied by the low-pressure compressor, engine operation is not appreciably affected.

Full cruise power of the B.E. 25 cannot be used on the Britannia aircraft. The wing structure would not tolerate the high speed. Apparently a new airframe must be designed to exploit fully the new engine. With the proper design, a cruising speed of 470 mph appears possible.

Helical Reduction Gear

Because of the great rotational speed of the high pressure turbine, the B.E. 25 requires an 11.1/1 reduction rear ratio. This ratio necessitates two stages of epicylic gearing. Helical gears are used to reduce vibration failure.

The reduction gearing and gear ratio on the B.E. 25 are the same as those used on the Proteus. The B.E. 25 gearing is rated at a shaft take-off power of 4000 hp.

(Paper on which this article is based is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Rain Erosion . . .

. . . becomes problem with supersonic aircraft. Ballistics method proves best for testing impact damage to materials.

Based on paper by **W. L. Dittman,** Convair Division, General Dynamics Corp.

THE kinetic energy of a raindrop impacting on a flat plate or stagnation area can exceed the allowable shear and tensile forces of many aircraft materials. To study this erosion effect, or impact damage, a ballistics method of testing materials has been used which employs a projectile modified to carry a test specimen.

The specimen is mounted in the nose of a 20-mm modified projectile and fired horizontally from a standard M-24 aircraft cannon through 500 ft of simulated rainfall. Upon firing, a tracer element in the projectile is ignited and burns for approximately ¾ sec. A black powder separation charge then ignites and expels the test specimen and parachute. Opening loads in the 6-in. vented-canopy nylon parachute are approximately 500 lb. The chute checks the forward velocity of the specimen within 10 ft, while the parachute and specimen land about 1500 ft from the firing point.

Rainfall is simulated by a 500-ft sprinkling system operated by a portable pump. Spray nozzles are at 10-ft intervals in a single line of pipe mounted 3 ft above ground. This produces a continuous uniform rainfall rate with an average raindrop diameter of 2 mm.

Nearly all specimens fired through the 500 ft of rainfall have shown some erosion damage, with different materials exhibiting different characteristics. Exposed aluminum has cup-shaped indentations similar to shot peening, whereas clear resin has a circular surface cracking around what appears to be the periphery of the drop impact. Where impacts overlap, chips of material are broken out of the surface. There is also evidence of sub-surface cracking.

The elastomeric coatings exhibit a third type of erosion. This consists of a small island of coating material surrounded by the bare base metal. Evidently on impact the drop compresses a cup-shaped area which would conform to the shape of the drop, then the water begins to flow radially to force the sides of the cup-shaped indentation away from the center of impact. If a high enough velocity is attained, the radial force will exceed the structural limit that the material can withstand, thereby washing the material away from the small compressed island. After the drop has washed from the impact area the initially compressed material regains a portion of its original state, leaving an island smaller than the drop's projected area surrounded by eroded material.

In order to permit a more closely controlled drop size investigation a second ballistics method was developed which employs for equipment 120 ft of 1¼-in. OD alloy steel tubing, a 20-mm smooth bored cannon, and a water drop producing device. The ID of the tubing matched the bore of the cannon barrel. The first 20 ft of tubing after leaving the gun barrel was perforated with pairs of ⅝-in. diameter holes diametrically opposed and spaced ½ in. apart and 90 deg out of phase. The remaining 100 ft of tubing was attached by means of a slip joint. A plug which is free to move is placed near the discharge end of the tubing.

The projectile is fired into the perforated tubing. The perforations permit the propellant gases to exhaust to atmosphere, bleed the pressure buildup in front of the projectile, and allow injection of water droplets into the tubing in the path of the projectile. When the projectile enters the 100-ft section of closed tubing the air is compressed, the projectile is decelerated, and the plug is accelerated. If the plug is correctly placed the projectile will reach zero velocity just as the plug leaves the tubing. Thus the projectile is prevented from rebounding to the gun and causing damage.

This captured projectile method provides an accurate research device for studying individual impacts of known drop sizes at various velocities up to Mach 2.6. By using high density liquids such as mercury as a drop source, damage sites produced at Mach 2.6 are equivalent to higher Mach numbers using water drops. (Paper "Supersonic Rain Erosion Testing Techniques" was presented at SAE Golden Anniversary Aeronautic Meeting, Los Angeles, Oct. 13, 1955. It is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

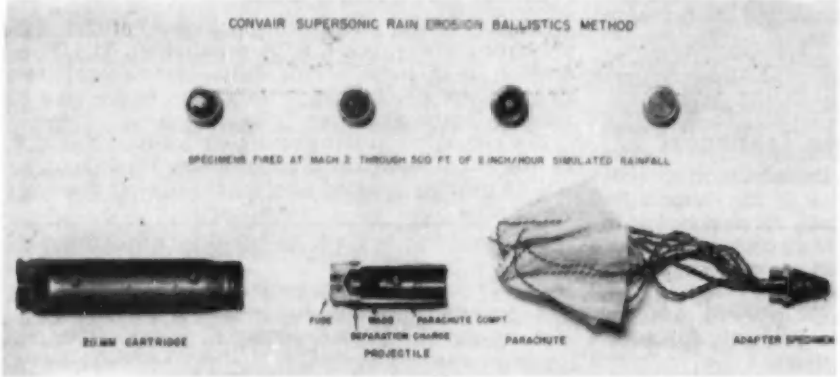


Fig. 1—Equipment used in ballistics method of testing materials for supersonic rain erosion. Speed can be varied from subsonic to Mach 2.6, at which speed successful specimen separation and recovery have been made.

A Report on

Jet Fuel Stability Studies

Why jet fuel breaks apart mystifies researchers. One thing they do agree, however, is that sulfur, nitrogen, and oxygen don't help any.

THE Air Force has been having stability trouble with its jet fuels. In supersonic aircraft, the fuel encounters extreme temperature changes before it is burned. These extreme changes break it apart chemically. As a result, sediment is formed which plugs nozzles and screens in the engine. Since the fuel is used as a coolant before it is burned, heat exchanger surfaces become fouled. The overall effect slows up the airplane.

Du Pont, Socony, Shell, and Esso—among others—have each been trying to improve jet fuel.

du Pont's Results

—C. M. Barringer, E. I. du Pont de Nemours & Co.

Jet fuels can be improved either by better refining or by adding chemicals.

Analysis of fuels revealed no relationship between fuel performance and gum, sulfur, olefin, and aromatic contents. Some of the poorest fuels in the Erdco test were lowest in gum and sulfur.

Analysis of filter deposits revealed high concentrations of sulfur, nitrogen, and oxygen which were originally present in the fuel only in trace amounts. Apparently, sediment is formed when inorganic components of the fuel react with dissolved air during storage. Heat accelerates the reaction. This sediment resembles chemically and physically the residues found in furnace oils after long periods of storage.

Fuels tested in the Erdco coker after 12 weeks of

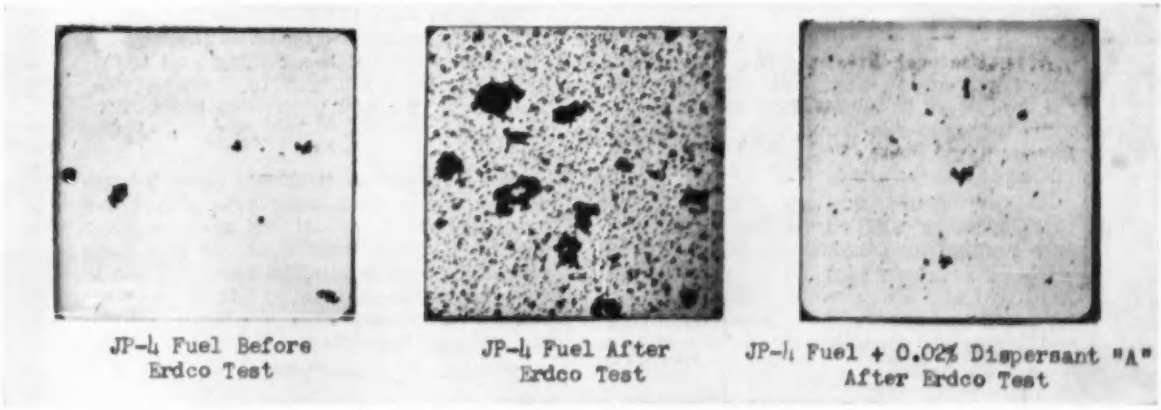
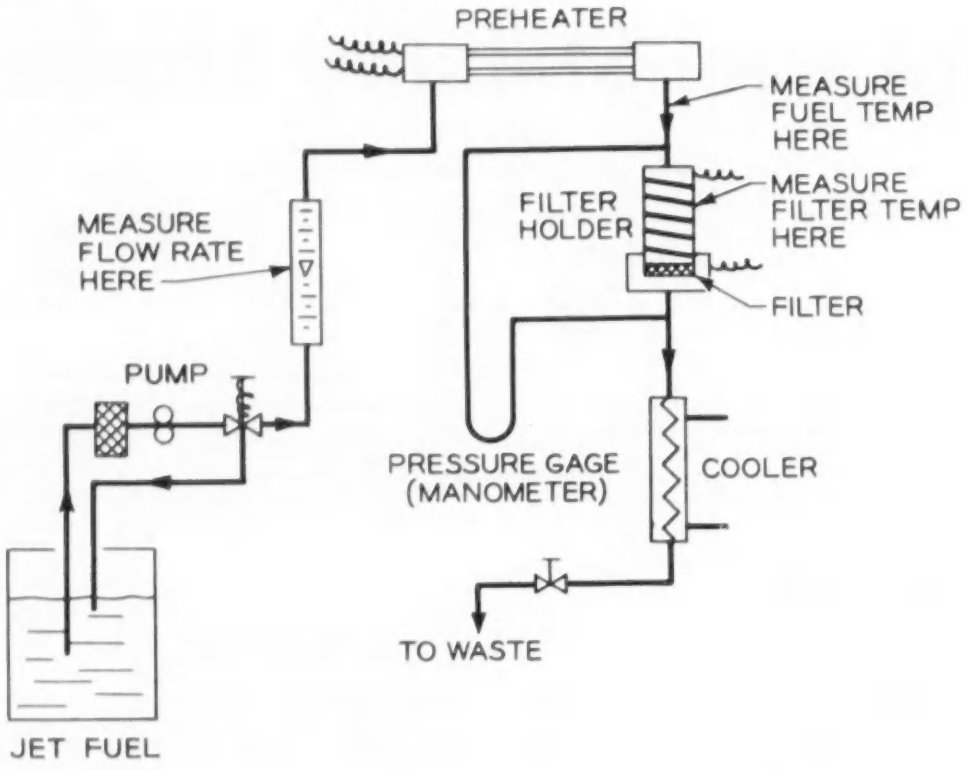


Fig. 1—Electron micrographs (4100X) of fuel sediment.
Left: JP-4 fuel before Erdco test. Center: JP-4 fuel after Erdco test. Right: JP-4 fuel plus 0.02% dispersant A after Erdco test.

The Erdco Coker Used in Fuel Stability Investigations



The Erdco coker (Fig. 1) is a miniature jet fuel system designed by Pratt & Whitney Aircraft. Fuel is heated to about 300 F in aluminum tubes in a preheater. This preheater is the lab version of an engine heat exchanger.

After the preheater, the hot fuel passes through a metal filter. The filter holder can be heated to 800 F. This holder simulates a nozzle receiving heat from a jet burner flame.

As fuel passes through the coker the filter becomes plugged, in time, and pressure builds up. Chemists have arbitrarily selected a pressure of 20 in. of mercury (9.81 psi) and a maximum time of 300 min as operating conditions. Other operating conditions are a constant flow rate of 4 lb per hr and a fuel pressure of 150 psig. A constant flow rate is used since this is an operating characteristic of an actual fuel system.

The more time the fuel takes to build up 20 in. of mercury the better is the fuel. A good fuel forms little sediment and therefore may take 300 min to build up this pressure. The fuel is then called a "300-min fuel."

The accuracy of the Erdco coker in predicting flight performance is still being investigated. In actual fuel systems under simulated flight conditions, 25-min fuels plugged the system in 2 to 4 hr. A 100-min fuel plugged the system in 7 to 11 hr. Test results varied even when the same fuel was run through the Coker over and over again.

storage showed an increase in sediment. This observation bears out the theory of chemical reaction during storage.

To remove inorganic components, fuel was passed through a column containing activated alumina. Then the fuel was tested in the Erdco coker. The fuel passed through the filter for 245 min before building up a pressure of 20 in. of mercury. Before the alumina treatment, this same fuel took only 28 min to acquire the same pressure.

A similar effect can be obtained by treating the fuel with acids or other additives. An acidified kerosene ran more than 300 min in the Erdco test as compared with about 100 min for an untreated kerosene.

Although gasoline antioxidants reduce gum formation during storage they cannot stop sediment formation when the fuel is heated.

Fig. 1 shows electron micrographs of fuels after passing through the Erdco coker. The increase in size and number of particles after heating is obvious. Also obvious is the effect of an additive on the same fuel.

(Paper on which this abridgment is based is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

What Socony Found

—D. P. Heath, C. W. Hoffman, and J. H. Reynolds,

Socony Mobil Oil Co., Inc.

Socony researchers concluded that better refining procedures hold the greatest promise for improving fuel. Procedures evaluated were solvent extraction and acid treatment, water treatment, and hydrocracking. Chemical additives were investigated also, however.

Socony's analyses of Erdco filter deposits agreed with those of du Pont. Further evidence was obtained when some pure organic hydrocarbons were run through the Erdco coker. After 600 min the pressure drop across the filter was almost negligible. Hydrocarbons cannot be responsible for sediment formation. Sulfur and nitrogen appear to be the culprits.

Socony's Erdco procedure differed in two ways from that of du Pont. A pressure drop of 25 in. of mercury was used, and if this drop was not obtained in 300 min the test run was extended to 600 min.

A West Coast crude was refined through various stages. The raw fuel ran only 57 min in the Erdco filter. When some of the inorganic components were removed by sulfur dioxide extraction the fuel improved to 119 min. Acid treating the extracted fuel improved it to 148 min. Water treatment of the acidified fuel improved it to 515 min.

Hydrocracking crude petroleum increases both the yield and stability of fuel. Heat content is increased and more complete burning occurs.

Hydrocracking occurs when petroleum is catalytically cracked with hydrogen at high temperatures and pressures. The process has become economical only recently.

In Fig. 2 note the improvement of a hydrocracked fuel over a straight-run fuel, each from the same crude source. This process may be one solution to the fuel stability problem.

Additives are most effective when contaminants have already been reduced by refining techniques

THIS article is based on four papers presented at the SAE Golden Anniversary Summer Meeting, Atlantic City, June 13, 1955.

"Stability of Jet Fuels at High Temperatures"

C. M. Barringer,
E. I. du Pont de Nemours & Co., Inc.

"Stability to Burn"

D. B. Heath, C. W. Hoffman, J. H. Reynolds,
Socony Mobil Oil Co., Inc.

"The Effect of Composition and Storage on Laboratory Properties of Jet Fuels"

A. C. Nixon, C. A. Cole, H. B. Minor,
Shell Development Co.

"Thermal Stability—A New Frontier for Jet Fuels"

A. B. Crampton, W. W. Gleason, E. R. Wieland,
Esso Research and Engineering Co.

Papers are available in full in multilith form from SAE Special Publications Dept. Price: $.35 to members, $.60 to nonmembers.

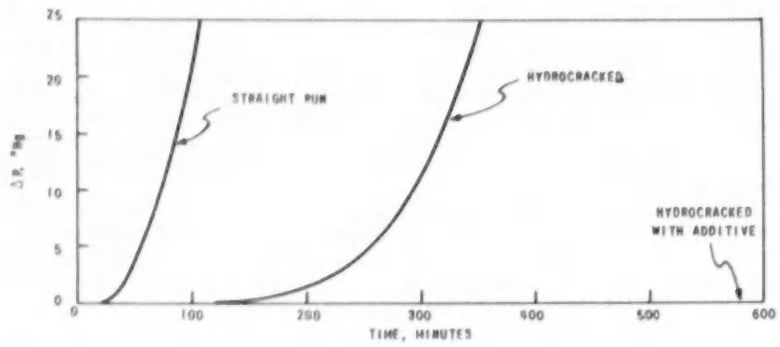


Fig. 2 Hydrocracked fuels don't clog Erdco filter as fast as straight-run fuel from same crude.

(Fig. 2). When an additive was used in the sulfur-dioxide-extracted West Coast crude, no improvement in stability was reported. When the same additive was used in the acid-treated fuel, however, a test time of more than 600 min was obtained.

Passing a straight-run fuel over heat exchanger tubes resulted in a heavy varnish-like deposit. Passing a water-treated fuel over the tubes resulted in much less deposit.

(Paper on which this abridgment is based is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Shell's Research

—A. C. Nixon, C. A. Cole, and H. B. Minor,

Shell Development Co

Shell investigated the effect of storage on fuel stability. Also, the effects of low, moderate, and high temperatures were investigated.

Four fuels prepared from Texas crudes at the same refinery were stored in drums for four years. Stability was measured by the amount of gum formed. The stability of the four blends decreased in the order straight-run, catalytically cracked, and thermally cracked. The fourth fuel, a composite blend of each of the other three fuels, was about as stable as the catalytically cracked fuel. An interesting observation was that the rate of gum formation slowed up considerably during winter.

From this company's experience, the stability of jet fuel is related to the stability of the gas oil fraction—that fraction of crude petroleum boiling above 400 F. Straight-run, catalytically cracked, and thermally cracked gas oils were obtained from a California refinery. Each of the three oils was blended with a stable gasoline to make three simulated jet fuels. The fuels were then stored in excess air at 110 F for six months.

After this storage the gas oils were distilled and subjected to various treatments: acid followed by caustic and redistillation; hydrogen bubbled through the oil followed by the addition of caustic; and hydrogen with caustic again, but followed by dilute acid. Each of the treatments reduced gum except the hydrogen-caustic acting on the catalytically cracked oil.

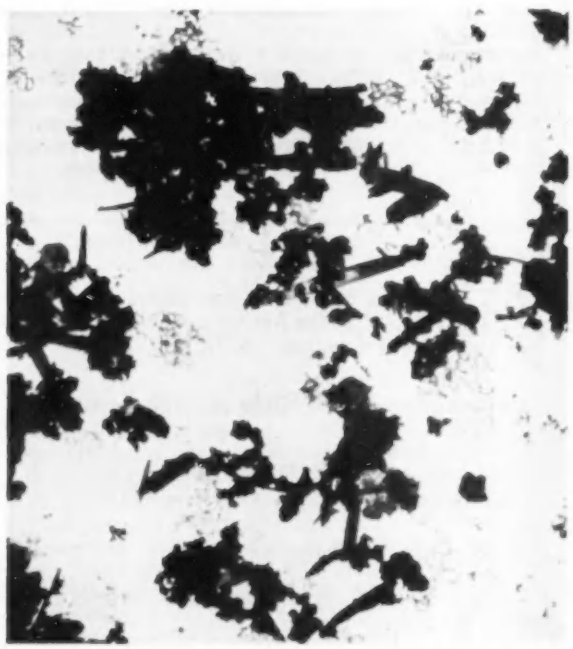


Fig. 3—Electron micrograph of crystalline (light particles) and amorphous (dark particles) gums filtered from fuel after desert storage.

Best results were obtained with the hydrogen-caustic-acid treatment. Small quantities of nitrogen bases were probably neutralized by the acid. Remember, one of the main constituents of fuel sediment is nitrogen.

The effect of excess air on fuel properties was studied. Fuels were stored for many months in drums. Some drums had 10% air space and others had 50% air space. Much more gum was formed in the drums with the larger air space.

A 1/64-in. hole was drilled in the cap of one of the drums. After one year little fuel was lost but much gum was formed.

Keeping air out of drums is more difficult than it appears. Even in a well-sealed drum some air is present. Usually, the fuel is saturated with air before it ever enters the drum.

After storage fuel is filtered. Of course, the more fuel that is filtered, the more the filter becomes plugged. Not all solids plug filters at the same rate, however, and therefore apparatus was designed to collect solids for analysis.

The apparatus consists of a hypodermic syringe driven by a constant speed motor. The syringe forces fuel through filter paper. A magnetic stirrer within the syringe keeps the fuel agitated. A constant flow rate of about 13½ ml per min was used for most of the tests. The pressure drop across the filter was measured with a mercury manometer.

Using this apparatus, chemists studied filter characteristics of several fuels, both at – 22 F and at room temperature. No filtration difficulties arose when the fuel was free of gum after storage.

Fuel saturated with water was also studied both at – 22 F and at room temperature. Particles of gum in the fuel probably act as nuclei for ice crystals or hydrocarbon hydrates which then plug the filter.

To study the effect of moderate temperatures (100 to 212 F) a small heat exchanger was added to the apparatus. At these temperatures the filter plugging tendency of the fuel is not related to the amount of gum it contains. With thermally cracked fuel, for example, the pressure drop rose steadily no matter how much gum was present. A mixture of straight-run and catalytically cracked fuels behaved similarly.

Filter deposits were examined under an electron microscope, Figs. 3–5. Four classes of gum were noted: crystalline, amorphous rigid, amorphous plastic, and grape-skin.

The more crystalline is the gum the less tendency it has to plug the filter. Note how in Fig. 4 the amorphous plastic seems to be changing over to the crystalline class. This effect may explain the varying behavior of fuels after shortage.

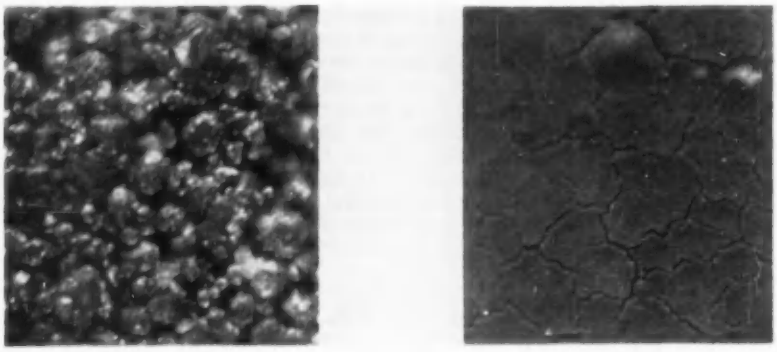
More work needs to be done, however, since interpretations of electron micrographs depend upon methods of sampling and methods of preparing the sample for examination. Furthermore, the class of gum is apparently not related to the type of fuel in which it is formed.

A modified Erdco coker was used to study the effect of high temperatures on fuel. A 5-micron filter was used instead of a 20-micron, and fuel was pumped at 250 instead of 150 psig. The fuel was recirculated after it passed through the filter the first time.

Filter times of straight-run fuels varied quite

Fig. 4.—Electron micrograph of amorphous rigid and amorphous plastic gums filtered from fuel after storage.

Fig. 5—Electron micrograph of grape-skin type gum filtered from fuel after storage.



BEFORE AFTER

Fig. 6—Micrographs (50X) of steel filter, before and after Erdco test.

widely. A California fuel plugged the filter in only 30 min. This result was probably due to the high sulfur and nitrogen in the fuel. Fuels from Mid-continent crudes lasted longer in the filter.

Some additives were investigated. Conventional gasoline antioxidants could not control the formation of gum and sediment.

Chemicals which keep fuel sediment dispersed were found to prolong filter times. These chemicals did not reduce Erdco heat exchanger scale, however.

Napthalene hydrocarbons appear to be at least partly responsible for the breakdown of fuels at high temperatures. The rate of sediment formation on the filter for these hydrocarbons is about the same as that of a jet fuel blend.

Oxygen, nitrogen, and sulfur are the principal elements in filter deposits (Fig. 6). The deposits resemble the residue left when fuel is oxidized in a bomb under pressure. The deposit particles were small enough to have passed through the filter; nevertheless, they readily adhered to the filter surface.

(Paper on which this abridgment is based is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Esso's Studies

—A. B. Crampton, W. W. Gleason, E. R. Wieland,

Esso Research and Engineering Co.

Both a bomb test and an Erdco coker were used at Esso.

Fuel was placed in a glass-lined bomb. The bomb was then purged with nitrogen. The only oxygen left in the bomb was that in the air which was dissolved in the fuel. After heating for a while, the bomb was taken apart and the fuel filtered. Fuels with additives formed less sediment on the filter than fuels without additives.

In another test, fuel was placed in the bomb in an oxygen atmosphere. Much sediment was formed. This suggests that perhaps jet fuel tanks should be blanketed with inert gas to keep out the oxygen.

Fuels tested in the Erdco coker behaved the same way as in an actual fuel system. When filter temperature and flow rate were varied, however, the time required to plug the filter changed. A study is now under way to determine more precisely the effect of Erdco operating conditions on test results.

Fuels obtained from different crude sources varied widely in thermal stability. Perhaps the answer to the fuel stability problem lies in selecting the right crude.

When acid was added to fuel it lasted longer in the Erdco filter. The minimum amount of acid necessary must be determined since corrosion problems will arise with acidified fuels.

Chemical additives are still being investigated. Some chemicals considerably decrease the amount of sediment formed. Additives must not introduce new problems, however, such as foaming, emulsifying the fuel, or interfering with low-temperature flow.

Sulfur, nitrogen, and oxygen appear to be the trouble makers. One of the additives normally added to fuel consists largely of nitrogen. Possibly this additive may be one of the sources of trouble.

Sediment examined under an electron microscope differed in appearance from sample to sample. Filter deposits from fuels with additives showed evidence of crystal formation, thus agreeing with Shell's results. The interpretation of shapes and sizes under the electron microscope is open to question, however.

More rigorous refining, the use of additives, and selection of the proper crude appear to be the most promising solutions to the fuel stability problem.

(Paper on which this abridgment is based is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

FULL SCALE CRASH TESTS using anthropomorphic dummies and lap-type seat belts are part of Ford Motor Company's safety test program.

SAE Recommends Test Procedures for

Motor Vehicle Lap Belts

THE SAE Technical Board has approved a Recommended Practice that sets up procedures for testing motor vehicle lap belt assemblies.

The tests, which were developed by the Committee on Motor Vehicle Seat Belts, specify that a seat belt assembly should be able to withstand at least 1500 lb in tension, and loop strength should be at least 3000 lb. These values are in agreement with Civil Aeronautic Authority requirements for seat belts currently used in civil aircraft.

A loop strength of 3000 lb is about the load which a 150-lb passenger would place on the belt when a car going 20 mph crashes into a rigid barrier.

Belts Are Anchored To Floor Pan

According to information collected by the committee, most seat belt manufacturers recommend that belts be anchored by bolts passing through the floor pan of the car body, with the bolt heads bearing against flat washers 2 to 3 in. in diameter on the under side of the pan.

If the belt, including buckle and length adjustments, is to be designed for 3000 lb loop strength, each of the fittings attaching the belt ends to the floor pan anchorage should be good for at least 1500 lb, and the anchorages together should be able to

The Motor Vehicle Seat Belt Committe is continuing to investigate seat belt problems. It is currently developing test methods for evaluating webbing mildew resistance, transverse stiffness, and abrasion resistance.

SAE Committee on Motor Vehicle Seat Belts

THIS Committee was organized by the SAE Technical Board in Sept. 1954 to investigate and report with recommendations on engineering problems of using lap-type seat belts in motor vehicles.

A. L. Haynes, Chairman —Ford Motor Co.

D. M. Baldwin —National Safety Council

Roderick Craves —American Motors Corp.

H. K. Gandelot —General Motors Corp.

Roy Haeusler —Chrysler Corp.

G. J. Lawton —Studebaker-Packard Corp.

D. J. Schrum Studebaker-Packard Corp.

R. F. Kohr, Technical Board Sponsor
Ford Motor Co.

take loads of at least 6000 lb. for two belts and 9000 lb for three. It is important also that the belt buckle can be opened easily after being subjected to the above loads.

The committee tested new 1955 car bodies (made by five different manufacturers) with $\frac{3}{8}$-in. anchor bolts and reinforcing steel washers on the top and under side of the floor pan. These washers or plates were $\frac{1}{8}$-in. thick and had an area of about 8 sq in. The test simulated a three-belt installation. That is, there were four anchorages with two belt ends attached to each of the inner anchorages. Balancers were used to distribute the load evenly among the anchorages.

In these tests, anchorages for front seat belts withstood 5000 to 9000 lb with floor pan deflections of 2.35 to 5.35 in. at the two inner anchorages and 0.30 to 1.93 in. at the two outer anchorages.

Rear seat belt anchorages withstood 5500 to 9000 lb with deflections between 1.76 and 7.75 in. at the inner anchorages and 0.17 to 5.60 in. at the outer anchorages.

Possibly somewhat higher loads than the above could be absorbed during a crash because they will be in action for only a fraction of a second.

Webbing Specifications

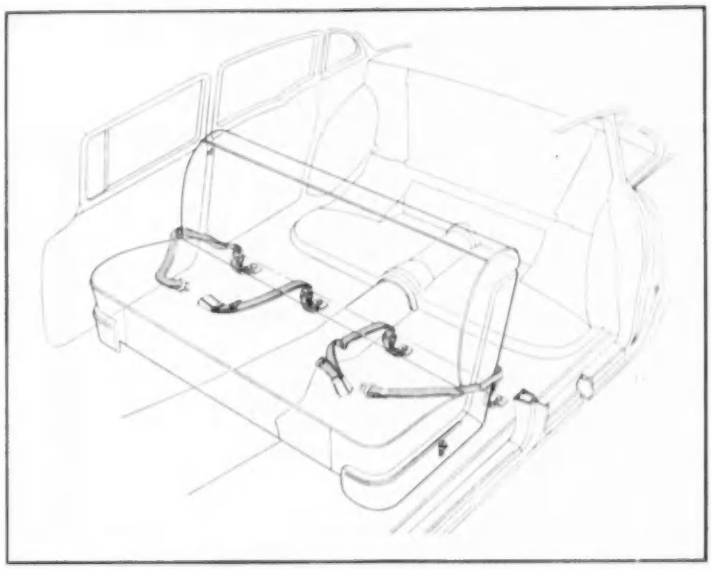
The new Recommended Practice specifies that the belt webbing should be not less than $1\frac{7}{8}$-in. wide and the tensile strength of the webbing material should not be less than 2250 lb for a one-person belt and 4500 lb for belts used by two persons. It should not curl or rope excessively under tension, or elongate more than 25% at these loads, and should resist mildew and abrasion.

Testing The Webbing

In testing the webbing, the new Recommended Practice suggests that three samples of webbing be selected at random from stock and mounted in a textile testing machine with heads 10 in. apart. Samples should be at room temperatures having a relative humidity of not more than 67% and temperature not more than 80 F.

The heads of the testing machine should separate no faster than 4 in. per min under no load. Each sample of webbing should withstand a load of 2250 lb without failure for at least 3 sec. For a belt to

SEAT BELT ASSEMBLY is tested for strength in the body structures laboratory of Chrysler Engineering Division. Engineering is observing an electronic "strain gage" which indicates forces being applied to the seat belts.



TYPICAL INSTALLATION of a seat belt assembly is Chevrolet's practice of anchoring belts by bolts passing through the floor pan of the car body.

be used by two persons, the rated minimum breaking strength is 4500 lb.

Testing The Belt Assembly

At least three identical samples of the belt assembly, including webbing, buckle, and all attachments and adjustment fittings, should be tested to have a minimum tensile strength of 1500 lb for a one-person belt, and 3000 lb for a belt intended for two persons.

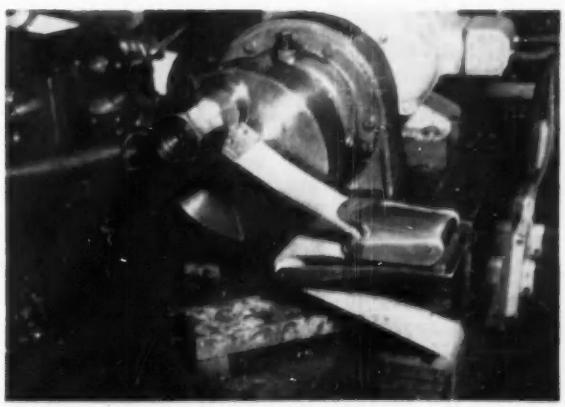
If a cam-type buckle is used, at least 10 in. of the free end of the webbing should extend beyond the cam when the buckle is in the locked position. The heads of the testing machine should separate at the maximum rate of 4 in. per min under no load. The buckle should be locked. The entire belt assembly should be aligned with the heads of the testing machine and tested at least to the rated strength. After the load is removed, the webbing and stitching should show no damage and the metal components should not be permanently deformed. The total slippage in the adjusting arrangement or the release mechanism should not exceed 1 in.

Testing The Release Mechanism

Three belt assemblies should be tested in a test jig with the end fitting attached to jig anchorage fittings located 10 to 20 in. apart horizontally. The belt should be suspended vertically. Test load should be 2850 lb for a one-person belt and 5700 lb for a two-person belt.

The load should be applied vertically downward through a 6-in. thick, semicircular wooden form having a radius of not more than 8 in. The curved portion of this form may have a cut-out to accommodate the belt buckle and may be padded to simulate the belt wearer's clothing. The test load should then be reduced to 250 lb for a one-person belt and 500 lb for a two-person belt. At these reduced loadings, the release mechanism should be operable at a force of not more than 45 lb.

After the loads are removed, the release mechanism should show no signs of failure or damage that will prevent operation of the release. Total slippage in the adjusting arrangement or release mechanism should not exceed 1 in.



WEBBING ABRASION is tested by Ford in this fixture. Belt, which is supporting a weight, is cycled through the buckle grip and cover lip to determine wear behavior. SAE Motor Vehicle Seat Belt Committee is currently investigating procedures to evaluate webbing abrasion resistance.

CRC

COOPERATIVE effort as a mechanism by which research projects of general interest to the automotive and petroleum industries can be studied is becoming increasingly important because of the tightness of technical manpower. It is interesting to note that the same general trend of technical thinking is evident in the various European countries, where definite interest is being shown in the organization of groups to carry out cooperative research similar to that being conducted by the CRC.

The shortage of technical manpower will be a continuing problem, and it is the responsibility of the CRC Assignment Committee to review critically all CRC projects to make sure that only those which are of vital importance to the petroleum and equipment industries or to the Military Services are carried as CRC activities. CRC Advisory Groups have been established to direct research programs for the Military which are being conducted by the Services themselves. Detailed research programs have been developed by CRC Groups, and commercial or university laboratories conduct the work under contract, following the specified detailed program established by the Group to insure that the project is carried on in the proper manner.

A functional chart, illustrating how projects which have been proposed for cooperative action are assigned to the appropriate technical committee and reports are issued, is shown on the following page.

The CRC is currently working on 48 individual projects dealing with 32 separate subjects. Over one-half of these projects were initiated by industry, continuing the trend toward increased emphasis on industry projects with the consequent decreased emphasis on military projects, which was started in 1953. During the past year, two projects have been combined, and two others, dealing with related phases of one subject, have been expanded to nine individual projects. Work on 13 individual projects, representing four new subjects, an amplification of three subjects, and two projects which are carried out on an annual basis, was initiated. Work on 14 projects has been completed, or completed except for the release of a final report, since the issuance of the 1954 Annual Report.

CRC Fuel and Equipment Research

The over-all organization of the Coordinating Fuel and Equipment Research Committee is shown in the organization chart.

Under the direction of the Coordinating Fuel and Equipment Research Committee, work is progressing on the development of a technique for measuring instantaneous temperature within the combustion chamber of an operating Otto-cycle engine. Two methods are being studied, (a) a sound-velocity technique developed by the Massachusetts Institute of Technology, and (b) an iodine-absorption technique developed by the University of Wisconsin. Each laboratory has set up apparatus to study its technique, and preliminary runs to check and calibrate the apparatus have been made. The resulting temperature measurements indicate that further

IN '55

development of the techniques should permit the devices to be used as laboratory tools in combustion research studies.

At the request of the Office of the Chief of Ordnance, an extensive program has been carried out studying the storage stability of aviation fuel, motor fuel, and jet and diesel fuel. As a result of this program, the Fuel Storage Stability Group recommended to the Ordnance Corps that a fundamental research project be initiated. In carrying out this recommendation, contracts have been negotiated with the U. S. Bureau of Mines, to consider primarily the identification and testing of various types of materials formed in the gum problem, and with Stanford Research Institute, to work on the mechanics involved in the formation of these gums. A CRC group has been organized to serve the Ordnance Corps in an advisory capacity in connection with these two projects.

Air Pollution Research

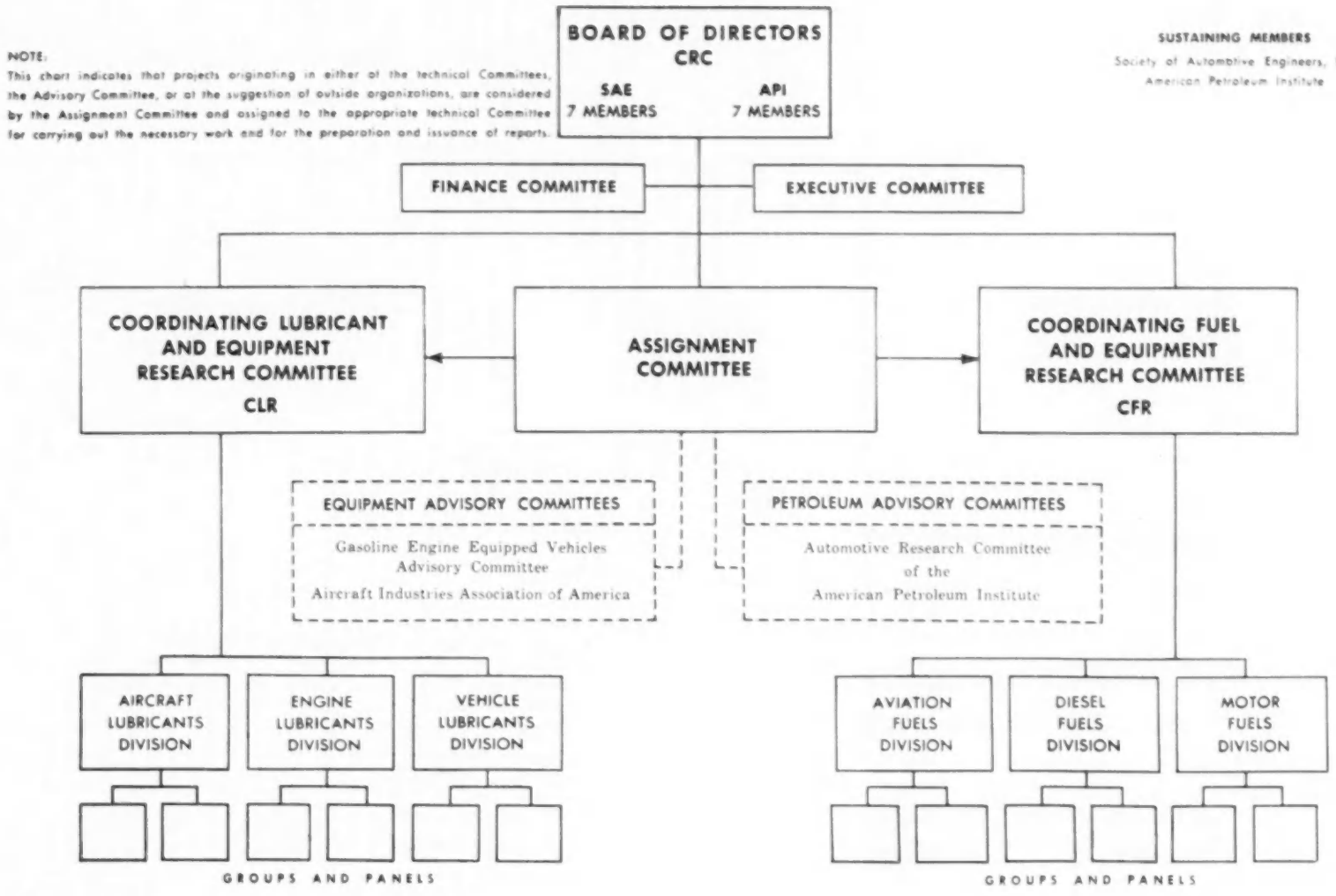
In recent months, there has been a wave of public interest in the subject of air pollution, influenced largely by the somewhat unusual meteorological conditions existing in the Los Angeles basin. The role played by automotive vehicle exhaust gas in air pollution is probably an important one, largely due to the concentration in certain areas of enormous numbers of vehicles, though its exact significance is still to be determined. As one step in determining this significance, early in 1954, the CRC received requests from the automotive and petroleum industries to study the composition of exhaust gas of automotive vehicles. A CRC Group was established, and work started on the study of techniques for the sampling and analysis of exhaust gas, the study of the effect of engine, fuel, and lubricant variables on exhaust gas composition, and a literature survey. The first year's work has developed satisfactory techniques for evaluating composition. A considerable amount of preliminary work on the effect of variables has been started. A vast amount of information and a number of reports have been collected. The next step will be to arrange for a preliminary field survey, using the available techniques.

The temperature-measurement, storage-stability, and exhaust gas projects, because they deal with the activities of more than one Division, all come directly under the supervision of the Coordinating Fuel and Equipment Research Committee. However, most of the fuel and equipment research investigations are assigned to the Aviation, Diesel, or Motor Fuels Division, and are covered in the discussions of the particular activities of these Divisions which follow.

The work of the CFR Aviation Fuels Division is now entirely concerned with the subject of gas turbines and their fuels. Because of the increasing interest in gas turbines for commercial transport aircraft, each program has been re-evaluated to insure that consideration is given to the inclusion of fuels that might be proposed for such use. There are two main classifications of projects, one dealing with fuel systems and handling of fuel within the modern high-speed airplane, and the other dealing with the combustion of the fuel in the gas turbine.

In the first group, two interesting programs have recently been completed. Test results from an investigation of the volatility characteristics of gas turbine fuels in modern fuel systems at very high altitudes and temperatures indicated, as expected, that the current JP-4 type fuels are unsatisfactory for aircraft use if heated, by aerodynamic heating or otherwise, to temperatures much above 200 F. For example, JP-4 fuel, when heated to approximately 450 F at very high altitudes, will exert a va-

FUNCTIONAL CHART FOR COORDINATING RESEARCH COUNCIL, INC.



por pressure inside a fuel tank of 200 psia. By contrast, a heavier fuel, such as Number 2 furnace oil, when subjected to the same conditions, will exert a vapor pressure inside a fuel tank of only 18 psia. To assist the aircraft fuel-system designer, a very comprehensive report, entitled "Volatility Characteristics of Aircraft Fuels at Elevated Temperatures," has just been issued. This report contains data on fuel volatility and vapor pressure at high temperatures and presents a relatively simple method for predicting tank pressures resulting from hot fuel.

Considerable work has also been done by the CFR Aviation Fuels Division on the low-temperature performance of gas turbine fuels during the past few years, particularly in regard to their pumpability and filterability. The conclusions from this work have indicated that:

(a) Filter clogging by wax crystals and solid contaminants can be controlled by selecting fuels of sufficiently low freezing point and sufficient oxidation stability, and by handling procedures, including adequate filtration to prevent solid materials from entering the fuel.

(b) Fuel selection cannot eliminate filter icing, nor can handling procedures prior to fueling the airplane. Variation of the water solubility of fuels with changes in temperature can cause unexpected results.

(c) Because of the marked influence of design factors, laboratory data do not provide a reliable basis for the prediction of the low-temperature performance of fuel filters and engine controls of an airplane. Special study of any given design may be necessary to insure satisfactory low-temperature performance.

The preparation of the volatility report was supervised by the Aviation Fuels and Systems Group, organized last year in accordance with a recommendation made at the Aviation Fuels Division Conference held early in 1954 that CRC Groups, composed of airframe industry and petroleum industry personnel, be organized on the West Coast to work on mutual problems. Another activity of this Group includes work in an advisory capacity with the Air Force in a program aimed to secure design information on the fluid-flow behavior of aircraft fuels in typical piping configurations at high-flow velocities. The Group has also prepared a proposal covering an analytical investigation of the basic factors affecting the rate of solution and evolution of gases in aircraft fuels which, after approval by the Aviation Fuels Division, was forwarded to the Air Force.

The importance of the high-temperature stability problem as related to aircraft gas turbine fuels has increased during the past months, as the future aircraft gas turbine fuel performance requirements have been recognized. To assist in arriving at a solution to this problem, a Group of the CFR Aviation Fuels Division has been organized, its objective being to develop a practical and valid laboratory test technique for evaluating high-temperature stability characteristics of aircraft gas turbine fuels and equipment.

In the combustion projects carried out by the CFR Aviation Fuels Division, studies have been made on carbon deposition in full-scale and laboratory-type burners, and on the fundamental combustion properties of fuels and their effects on burner performance. Two cooperative programs on carbon deposition have been completed, and a proposal for a third cooperative program has been prepared. The latter program has been formulated with the objective of (a) refining current test techniques, and (b) identification and evaluation of fuel properties governing deposits and exhaust smoke and flame radiation.

A considerable amount of test work has been completed on fundamental combustion properties of fuels, and a report prepared. Using pure hydrocarbons, a qualitative relation between flame velocity and "combustion efficiency" has been described. However, no additional program is being proposed at this time on this phase of the work.

Railroad Diesel Program

A very practical field test program on railroad-type diesel engines in actual service carried out under the direction of the CFR Diesel Fuels Division is almost completed. Some years ago, it was foreseen that the type of fuel oil available to the railroads might change in nature from the straight-run, fairly high-cetane-number fuel on which the engines had been developed, and all the initial service experience obtained, to a catalytic-cracked gas oil of lower front-end volatility, somewhat lower cetane number, and higher sulfur content. Accordingly, tests were run on eight railroads, involving three different types of engine and eight different fuel suppliers. The tests were designed to study the effect of the use of high-sulfur, low-cetane-number, high-end-point diesel fuel, when run against normal-type high-cetane-number straight-run control fuel.

Each test was continued over a year's operation on a given railroad, in heavy-duty freight service, in normal passenger-car service, or in switching service. Thus, a very comprehensive set of data was obtained on a comparative basis on two types of fuels. The data from the two final series of tests are still to be analyzed. It is expected that a final report will be prepared shortly, covering all the tests and including some additional work done on smaller full-scale automotive-type diesels as well as detailed analytical work carried out by the Bureau of Mines.

Recently, at the suggestion of a number of engine manufacturers, the CFR Diesel Fuels Division has given serious consideration to the significance, in terms of full-scale engine performance, of current laboratory techniques for the determination of diesel-fuel ignition quality. A study has been made of the large amount of work done in various individual laboratories on fuels of varying ignition quality, and the effect of fuel ignition quality on full-scale engine performance, particularly with relation to starting, warm up, and operation under variations in speed and load.

Related to this ignition-quality investigation has been some fundamental work undertaken by the U. S. Bureau of Mines on ignition delay in a constant-volume bomb. The study was sponsored by CRC and guided by an Advisory Group from the CFR

Diesel Fuels Division. The constant-volume bomb is a reaction chamber which can be charged with air to a given pressure and maintained at a constant temperature. A measured quantity of fuel can be injected into the quiescent atmosphere of the bomb in a single injection, and the subsequent pressure-time history of the reacting air-fuel mixture can be recorded, using a suitable type of cathode-ray oscillograph. This work was publicized at the American Petroleum Institute meeting in May 1955, in a paper entitled "Auto-Ignition of Fuels in the Constant-Volume Bomb, Effects of Operating Variables and Fuel Structure."

The CFR Diesel Fuels Division is also working on the development of an improved type of smoke-meter. The present meters fail to correlate with the density of visible exhaust smoke, and several new types of meters are being tested. Considerable success has been obtained using the filtering-type continuous-recording gas sampler for measuring the relative density of smoke in the visible and invisible range.

Combustion Deposits

The subject of deposit-forming characteristics of diesel fuels and engines has recently received a great deal of attention by a Group of the CFR Diesel Fuels Division which was appointed to accumulate and review all readily-available information, both published and unpublished, relating to this subject. A very comprehensive report will be issued shortly, dealing with the influence on the formation of deposits of such factors as engine design, engine operating conditions, and fuel characteristics. The deposits considered are those encountered as the result of the combustion of the fuel rather than those due to fuel instability prior to injection.

In this same general program, an Advisory Group has been assisting the Navy Bureau of Ships in programming full-scale submarine engine tests to evaluate the effects of fuels from foreign sources which might have a relatively high sulfur content, and which might have to be used in an emergency under emergency operating conditions, such as long periods of snorkelling.

During the past few years, a number of the laboratories active in the CFR Motor Fuels Division have individually been responsible for some extremely interesting work on the subject of combustion-chamber deposits in automobile engines. This has led to the initiation of a new program on the study of surface ignition. In this field, standardization of terminology, a review of surface-ignition instrumentation, and a study of surface-ignition reference fuels have been considered the projects most worthy of cooperative study.

It is expected that the standardization of terminology, which is covered in a report released to industry in June, 1954, will go a long way toward clearing up misunderstandings and correlating an immense amount of work which is being carried out in the various laboratories of the petroleum and automotive industries. The review of surface-ignition instrumentation is proceeding rapidly, and a number of different types of instruments are being studied.

Octane Number Requirements

For many years, the CFR Motor Fuels Division has been concerned with the octane-number requirements of passenger cars and trucks as they are operated in the hands of the public, and according to the specifications of their designers. In 1950, a four-year program was established with the following objectives:

(a) To supply statistical information on octane-number requirements of the post-war car population.

(b) To study the octane-number requirements of selected makes and models having new-design engines or transmissions (new-design cars).

In 1951, the first year of the program, a statistical survey of 1946–1951 models was conducted. This survey gave results nearly identical to those of the 1949 statistical survey. Data on three makes having new-design engines and transmissions were also obtained. In 1952 and 1953, the work was devoted entirely to the study of makes having new-design engines and transmissions. The 1954 program included a statistical survey of 1950–1954 model cars in addition to studies of the requirements of nine 1954 makes having new-design engines and transmissions. In these latter tests, it was noteworthy that, of the cars reported to be spark-knock or surface-ignition limited on the primary reference fuels, 96% were spark-knock limited and 4% surface-ignition limited.

As might well be expected from a study of octane-number requirements and the octane numbers of gasolines currently being marketed, the subject of an extension of the octane scale is becoming increasingly important. Two years ago, some proposals were suggested for trial by interested laboratories, and, more recently, a symposium was held under the auspices of the CFR Motor Fuels Division to bring out further ideas as to the best means of extending the scale. The subject has, of course, been covered for many years with respect to aviation fuels, but the operating conditions and types of equipment used are different for motor fuels. Furthermore, the need for avoiding a sharp break in the scale at the 100-octane-number point is more critical when working with motor gasolines. A Group has been organized to study this problem.

Vapor Lock Investigation

Vapor lock and the associated problems of hot stalling and hot starting in passenger cars and commercial vehicles are being carefully studied by the CFR Motor Fuels Division. The petroleum industry, from time to time, has indicated interest in raising the vapor pressures of gasoline. The advent of automatic transmissions has, at the same time, made the subject of stalling a much more sensitive one, and much more noticeable to the average driving public. Consequently, in 1953, a very comprehensive survey, covering a total of approximately 140,000 cars, was made of the difficulties being experienced in service

throughout the United States. Because there was some question as to the uniformity of the techniques used, a second survey was conducted in 1954 to determine whether the preliminary indications were confirmed. In a separate program, a new technique was developed for evaluating the vapor-locking characteristics of individual cars, which permits the study of vapor lock, hot stalling, and hot starting during a single test schedule.

Assisting Army Ordnance

Since 1951, the CFR Motor Fuels Division has been actively assisting the Office of the Chief of Ordnance in the evaluation of vapor lock, octane requirements, and cold-starting characteristics of current and future military equipment, and also aiding in training Ordnance personnel in the conduct of this type of testing. Extensive tests on these problems have been carried out at various Army proving grounds and have proved extremely beneficial in improving the design and performance of certain military equipment, using combat-type gasolines.

During the past two years, Ordnance personnel demonstrated that they could conduct tests of this type without further supervision or assistance from CRC personnel, and indicated their satisfaction with the results being obtained. Therefore, no CRC observers were assigned to the 1954 tests run at the Ordnance Climatic Test Station, Yuma, Arizona. However, recent information indicates Ordnance interest in tests covering the evaluation, in Ordnance equipment, of fuels of higher Reid vapor pressure than those currently covered by the military specifications, and a CRC Study Group is being formed.

CRC Lubricant and Equipment Research

Because of the increased interest in lubricant problems, a reorganization of the Coordinating Lubricant and Equipment Research Committee into the Division type of structure, as shown in the organization chart was put into effect a year ago, and is proving to be extremely worth while. Organization meetings have been held for each of the three Divisions—Aircraft Lubricants, concerned with lubricant and equipment problems in aircraft, including the aircraft engine; Engine Lubricants, concerned with lubricant and engine problems; and Vehicle Lubricants, concerned with lubricant and equipment problems in all parts of the vehicle except the engine.

A comprehensive study of airframe lubricants and equipment is being carried out by the CLR Aircraft Lubricants Division at the request of the Air Force and the Navy. The purpose of this work is to determine the lubricant requirements of the various mechanisms built into the airplane so that changes in both the aircraft or accessory design and the lubricant can be made to obtain the best over-all effectiveness. Included in this study are the problems of rust prevention, high-temperature operation, and fret corrosion, as well as instrument-bearing and plain-bearing problems.

Bearing Corrosion

Service data on the wheel-bearing corrosion problem, on the incidence of fretting corrosion, and on antifriction bearings for electronic equipment have been made available to the appropriate Laboratory Study Panels. These Panels are working on the development of techniques covering high-temperature testing of greases, fretting corrosion, rust-preventive properties of greases, plain bearings, and screw thread and gear mechanisms. A progress report covering the first phase of this work has been issued. Final conclusions on the value of the techniques contained in the report must await the results of field tests. It must be emphasized that all these tests, both service and laboratory, necessarily take considerable time to carry out, since long life is the basic factor which has to be measured. Experience has shown that it is impossible to shorten laboratory time appreciably, and still maintain adequate correlation with service data.

The CLR Aircraft Lubricants Division has been assisting the Air Force in connection with the development of a bearing test rig for studying problems connected with the main thrust bearings of gas turbines. The cooperative design has been completed and the Air Force is arranging for the construction of one of the test machines, which will be made available to industry for general research and development work.

Oil Test Engine

For the past few years, the need for a special oil test engine has become increasingly urgent. This urgency became vital when the General Motors Corporation notified the CRC that, after 1956, the supply of Chevrolet engines used for L-4 testing for sludge and bearing corrosion would no longer be available. A special survey team visited about 40 different oil company and engine company laboratories during 1952, and, in view of the information secured in these interviews, reported certain basic requirements. An Engine Design Panel was authorized to make arrangements for a design study with suitable manufacturers and to come up with a suitable design, keeping in mind these basic requirements. As a result of this work, a manufacturer was selected, a design approved, and a prototype engine built.

Twenty-five of the new CLR Oil Test Engines are now in the hands of a number of laboratories cooperating in the work of the CLR Engine Lubricants Division. This first batch of engines is being used primarily in a technique development program, with

the expectation that a test will be available to replace the L-4 test before the end of 1956. Preliminary results are satisfactory, and it appears that the engine will prove very valuable for oil test purposes. Increased activity can be anticipated during the next few years as the various CLR Groups start using this engine to study wear, cleanliness, and oxidation problems. A paper discussing the development of the engine was presented to the Fourth World Petroleum Congress.

Varnish And Sludge

An important project of the CLR Engine Lubricants Division covers an investigation of engine varnish and sludge. Its objective is to develop "know-how" which will permit a laboratory to obtain in laboratory engine tests the types of engine condition, such as deposits, wear, etc., which are encountered in several types of engines in various types of field service. A comprehensive program is under way to explore the effects of equipment variables, and to check reproducibility and repeatability. Tests have been set up on a statistical basis. Standard data forms have been prepared and distributed to participants as an aid in providing uniform data, and simplifying the analysis work. Reproducibility among laboratories with respect to piston varnish and side-cover sludge ratings has been improved by the use of photographic reference charts, which are now being made available to all participants. If this rating system proves satisfactory, it will be expanded to include other engine items.

Cam Wear Data Sought

A study of a specialized form of wear has recently been undertaken by the CLR Engine Lubricants Division. The engine manufacturers have indicated that a problem of excessive wear on cams, cam followers, and gears has developed in higher horsepower output engines now being installed in passenger cars. Preliminary surveys showed that engine design, lubricating oil, and metallurgy all had a definite effect on the problem, and a cooperative project to obtain some organized field data was set up. Approximately 300 cars, representing eleven different makes and models, will be run on a number of engine-oil combinations for a period of at least a year. Four test oils will be used and specially selected lifters installed in various cars prior to the test. The cars will be driven in normal passenger car service in various areas throughout the United States.

Railroad Diesel Lubricants

Recently, at the request of the Association of American Railroads, the CLR Engine Lubricants Division has agreed to study the subject of lubricating oils for railroad diesel engines. The broad objective of this project is the determination of the mutual interdependence of different types of lubricants and different types of railroad engines under a variety of operating conditions, recognizing the mutual effect of railroad fuels. As a preliminary step, a survey of field experience will be conducted, to summarize the available information on the problem. Then, if warranted, field service tests will be organized, to permit the development of field service techniques capable of predicting results representative of railroad service, and the concurrent development of laboratory techniques capable of evaluating the effects of lubricating oil, engine design, and operating conditions.

Over a period of years, the CLR Ordnance Lubricant Performance Group cooperated with the Ordnance Corps in the investigation of the engine-lubricant relationship in Army engines. At the completion of various phases of the test programs, CRC Inspection Teams reviewed the tests and inspected the engines. Results of this work indicated some engine modifications were necessary for optimum performance, and these changes have been included in the new engine designs. The various projects initiated in connection with this work were carefully reviewed at the time of the reorganization of the CLR and the purely advisory functions were transferred to the Engine-Fuel-Lubricant Relationship Group. The remaining activities have been consolidated into one project coming under the supervision of the CLR Engine Lubricants Division, and the future program will depend upon requests from the Ordnance Corps.

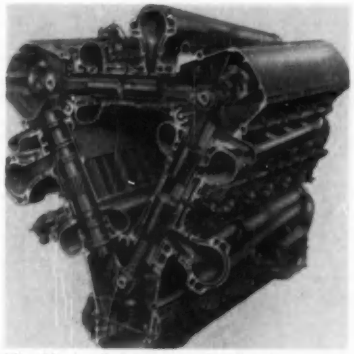
Rear Axle Survey

A number of companies in the petroleum industry have indicated concern with rear-axle failures in passenger cars. Information submitted to the CLR Vehicle Lubricants Division has indicated that, while a few years ago the lubricants meeting Military Specification MIL-L-2105 were performing satisfactorily, due to an increase in power output and speed, there has been a general trend towards difficulties under conditions of high-speed operation. Also, the load-carrying ability of gear lubricants has been taxed by the additional loads being imposed in both commercial and military vehicles. Plans have been made for comprehensive surveys of these problems, and studies of the reproducibility and severity level of the two techniques in current use for measuring load-carrying capacity in rear axles under conditions of high speed, and high torque and low speed, are under way.

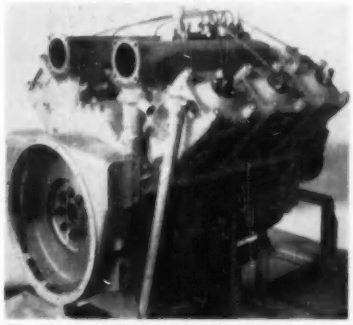
Automatic Transmission Fluids

The CLR Vehicle Lubricants Division is also studying the subject of automatic-transmission units and power-steering units and their fluids. A test technique using a commercial transmission unit has been tentatively established. The first work has been done on common reference fluids, including acceptable, unacceptable, and borderline oils, the object being to determine whether this transmission can be used, and what modifications are necessary to make it suitable for employment as a test apparatus. This work is proceeding smoothly, but, of necessity, each test is of a fairly long-term nature.

New Shapes Make Diesels More Compact



The Napier Deltic triangular diesel



The White V-6 truck diesel engine

Continental's Four-stroke V-8 diesel

THE trend in diesel engines is definitely toward securing more power from given space and weight, the SAE Golden Anniversary Diesel Engine Meeting proved.

The Meeting was held Nov. 3–4 in the Chase Hotel in St. Louis. It drew engineers interested in truck, bus, and locomotive diesels. They came from all over the country, and the views they expressed were as varied as their backgrounds, which included training in at least 10 countries besides the United States: Germany, Hungary, India, Egypt, China, England, Canada, Switzerland, Austria, and Holland.

Truck diesels are assuming V shapes to put more power in a shorter under-the-hood space. They and all other types of diesel engines discussed at the Meeting are speeding up to deliver more power out of a given amount of metal.

Continental has developed a four-stroke-cycle V-8 diesel that delivers 200 hp at 2800 rpm and weighs 1525 lb. Earl Ginn, who described the engine in one of the Meeting's five sessions, revealed that this diesel engine's otto-cycle counterpart operates satisfactorily up to 3600–4000 rpm. He foresaw the diesel version operating close to the same range, eventually.

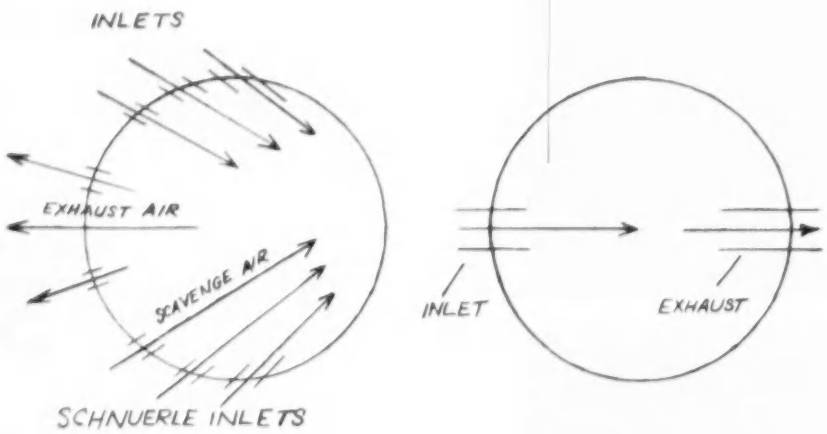
The Continental engine incorporates an "energy cell" in the head opposite the injector. The cell absorbs and delays ignition of part of the fuel and air charge. It levels off cylinder pressures, thus reducing stresses on operating parts, it was explained.

White has brought out two-stroke V diesels in both a four-cylinder and a six-cylinder version. The four-cylinder diesel delivers 170 hp and weighs 1090 lb in principally aluminum construction and 1355 lb when some major components are cast iron. Corresponding weights for the six-cylinder 255-hp diesel are 1530 and 1900 lb, as given by W. F. Burrows and H. W. Hanners of White.

From rear of flywheel housing to front of fan, the four-cylinder White diesel is 42⅞ in. long. The six-cylinder diesel is 52½ in. long.

The White engine is an adaptation of a Krauss-

SCHNUERLE SYSTEM OF LOOP SCAVENGING used in White diesel was explained by Prof. A. W. Hussmann of The Pennsylvania State University, after presentation of the description of the White engine. Above facsimile of his sketches illustrates the Schnuerle system in cross-section at the left. Scavenge air is directed against wall opposite exhaust ports. Rising piston forces air upward. Air doesn't escape via exhaust ports until it has thoroughly scavenged the chamber.



The Schnuerle system prevents the scavenge air from "short circuiting"—as is possible where exhaust ports are opposite inlet ports (right above) or where inlet and exhaust ports are on the same side of the cylinder.

Hussmann worked with Schnuerle in Germany on application of the scavenging system to various diesels. The Germans used it for truck and marine engines and for an aircraft engine of 2500 take-off hp.

CRC Turns to Filter-Type Smokemeter

In response to numerous unfavorable comments about the CRC (photoelectric) Smokemeter, the CFR Diesel Fuels Division of the Coordinating Research Council reviewed other instruments for measuring smoke in diesel engine exhaust. The idea was to recommend a more suitable type of instrument.

Of the several types considered, a continuous filtering-type tape-recording smokemeter has been tested cooperatively and found superior. It appears suitable for development of engines, for improvement of fuels, and as a service tool for locating faults in engine maintenance and operating practices.

The Division's investigation will culminate in a recommendation by CRC defining the construction and mechanism of a continuous filtering-type smokemeter adapted to quantitative measurement of smoke in diesel exhaust gas, it was reported.

The work has been done with the Von Brand Continuous Filtering Gas Sampler. But, it was explained, the recommendation will not restrict construction of the instruments to any one source.

Maffei design. It employs Schnuerle-type loop scavenging.

Both the Continental and the White diesels are aimed at saving cab length. Now that legislation restricts over-all vehicle combination length, a few inches saved on cab length afford an appreciable increase in maximum legal cargo-carrying volume.

The Napier Deltic has assumed an even more unusual shape for a diesel. It is triangular. On each side of an equilateral triangle lies a bank of cylinders containing opposed pistons. At each corner of the triangle is a crankshaft serving the two adjacent banks of pistons.

Deltic engines appear in nine-cylinder and 18-cylinder forms. The 18-cylinder engine produces a maximum of 2730 bhp. It weighs 8860 lb. Maximum speed is 1500 rpm.

The engine is in British naval and locomotive use. The repair-by-replacement philosophy underlying its design makes it easy to maintain, claimed Napier's Ernest Chatterton.

An engine speed of 1500 rpm didn't impress American diesel men as "fast." But 1500 rpm is "high speed" to builders of European railroad diesels, reported Richard Herold of Sulzer Bros. Ltd. of N. Y.

When American builders mentioned "high speed" in regard to diesels, they referred to speeds approaching those of gasoline engines—speeds as high as 5000 rpm. If diesels are to run this fast, we must know more about what happens within the combustion chamber after the fuel has been injected and before it starts to burn, they agreed.

Part of this ignition lag is due to fuel vaporization. Part is due to the occurrence of chemical changes, researchers from the University of Wisconsin and the Bureau of Mines Petroleum Experiment Station at Bartlesville, Okla. agreed. They reported on experimental studies conducted in actual engines and in bombs and on analytical studies employing digital computors for elaborate calculations.

Their conclusion: Major differences between fuels

of varying cetane number lie in the way in which they release chemical energy during the very early reactions.

The researchers were careful to explain that the physical effects delaying ignition occur simultaneously with the chemical effects. They refer to the first part of the ignition delay period as the "physical delay" and the later part as the "chemical delay" only because of the difference in the predominating effect. The physical delay period—that is, the vaporization period—doesn't vary much from fuel to fuel, even when the fuels differ considerably in volatility.

Prof. P. S. Myers of the University of Wisconsin reasoned that this might be due to the fact that we rate the volatility of a fuel at room temperature. At the temperatures prevailing in diesel combustion chambers, rate-of-vaporization differences may be much smaller between fuels.

Continuing he said, if you squirt a droplet into the air, you can't boil it. There's nothing to conduct heat to the liquid from the surrounding vapor. Therefore there's a limit to how fast you can vaporize fuel droplets in air. But this limitation doesn't exist on a metal surface.

With metals, there's an optimum temperature for vaporization, he commented. Below a certain temperature, metal won't vaporize fuel at all, of course. But above a certain higher temperature, metal won't vaporize fuel quite as fast as within an intermediate range.

Maybe the M.A.N. "Whisper" engine succeeds because its pistons operate in this optimum temperature range, he mused.

He suggested that there's a need for large-scale turbulence to carry fuel to metal surfaces, rather than a need for small-scale turbulence to mix fuel and air.

B&O Tries Variety of Air Filters

The Baltimore and Ohio Railroad is service testing three types of air filters in addition to the usual panel-type filters, it was announced in a progress report by Pell Kangas. The three are: centrifugal filters, oil-bath filters, and electrostatic filters.

Final criterion will be wear rate of engine parts. Meanwhile, B&O researchers are keeping tabs on the dust by installing oiled glass slides before and after air cleaners. These they examine microscopically to catalog dust particle sizes. Eventually they hope to determine which particle sizes predominate and which cause the most wear. Then they will have a check on which type of air cleaner is best for their particular service.

Discussion of the B&O test program brought a plea for a cooperative test program in which a number of filter manufacturers and dieselized railroads would participate. Lab engine tests run with a variety of types of dusts would give results that each railroad could use for each area in which it operates.

This Article . . .

. . . is based on the following papers presented at the SAE Golden Anniversary Diesel Meeting, held at St. Louis, Mo., November 2–4, 1955

M. M. EL WAKIL, P. S. MYERS, and O. A. UYEHARA
University of Wisconsin
"Fuel Vaporization and Ignition Lag in Diesel Combustion"

W. F. BURROWS and H. W. HANNERS
The White Motor Co.
"Design and Development Experience—White V-106 Diesel"

ERNEST CHATTERTON
D. Napier and Son Ltd.
"The Napier 'Deltic' Diesel Engine"

H. C. HUNTER
Leader of the Smokemeter Group of the CFR Diesel Fuels Division
"A Continuous Filtering-Type Smokemeter for Automotive Use (Progress Report of the CFR-DFD Smokemeter Group of Coordinating Research Council)

O. A. UYEHARA and P. S. MYERS, University of Wisconsin
"Physical and Chemical Ignition Delay in an Operating Diesel Engine Using the Hot-Motored Technique"

R. W. HURN, J. O. CHASE, D. F. ELLIS, and K. J. HUGHES
U. S. Bureau of Mines
"Fuel Heat Gain and Release in Bomb Autoignition"

E. C. GINN
Continental Motors Corp.
"Meeting Present Day Power Requirements with a V-8 Diesel"

PELL KANGAS
Baltimore and Ohio Railroad
"Air Filtration and Diesel Engine Wear—A Progress Report"

W. A. HOWE
Gulf Oil Corp.
"Factors Affecting Diesel Smoke in Highway Operation"

T. C. YU, University of Wisconsin
R. N. COLLINS, Continental Oil Co.
K. MAHADEVAN, Indian Institute of Science

RICHARD HEROLD
President, Sulzer Brothers Ltd. of New York
"Status of Diesel Locomotives in Europe"

Turnpikes and Traffic

TURNPIKES and traffic are giving modern engines a hard time, but automotive and petroleum engineers, aware of these difficulties, are well girded to meet them. This was most clear from papers and discussion at the SAE National Fuels & Lubricants Meeting, held in Philadelphia on Nov. 9 and 10.

For example, a common type of operation consists of sustained high-speed driving—often on turnpikes—followed by a long stretch of idling, when traffic becomes dense. Coupled with this is the increased congestion found underneath the hood of modern high-powered cars (see Fig. 1). Result, often, is an overheated fuel system, ripe for vapor lock or kindred troubles.

These engines, with their high power and high compression ratios, need high-octane gasoline. As turned out in today's refineries, such gasoline is highly sensitive. This means that a gasoline rating high in octane numbers in one engine may rate much lower in one of different design.

Alleviation of difficulties involving the fuel are being sought directly through gradual improvements in engine and fuel. Another more radical approach is by the development of fuel injection. Many companies are working on fuel injection, finding, as usual with any new development, that it is solving some problems and introducing new ones of its own.

As contrasted with high-speed driving on turnpikes, much other driving consists only of short trips at low speed. The engines never get a chance to warm up thoroughly. Curse of this so-called severe light-duty operation is low-temperature sludge—deposits formed in the crankcase, on push-rods, rocker arms, and timing gear areas.

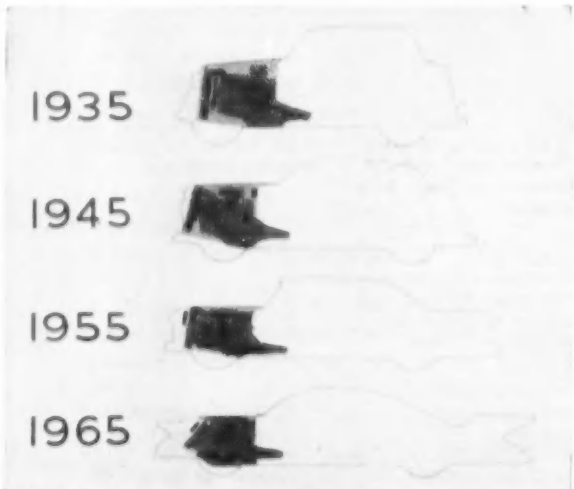


Fig. 1—As the years go by, the space underneath the hood is becoming more and more congested. This reduces the volume of air that should help to ventilate the carburetor.

Hot Fuel Handling Problems

Extensive surveys to find out the extent to which cars suffer from vapor lock, hot stalls, and poor hot starts show that cars and gasolines are fairly well adapted to each other and to the needs of the driving public. Oddly enough, two high-volume cars showed up appreciably better than average, while several luxury models were worse than average.

Despite the low overall incidence rate of vapor lock, continued study is justified because (1) of the high nuisance value of even occasional vapor locking and (2) it appears that it will become more serious as time goes on, unless plenty of attention is given to its abolition.

That there is a tendency toward more vapor locking is shown by Fig. 2. Note that postwar cars are worse in this respect than prewar models. Some of the reasons might be listed as follows:

1. Increased engine power and power utilization by auxiliaries.
2. Cooling system capacities have not, in many cases, kept pace with increased engine power and heat-dissipation duties.
3. Decreased engine compartment coolant air

Test Modern Engines

effectiveness, due to styling and auxiliaries disposition.

4. Increased engine operating temperatures.

This problem is also being studied by a CRC committee—the CFR-MFD Volatility Group. It has developed a proposed technique that appears to furnish a usable guide for determining passenger-car hot fuel handling characteristics under level-road operation.

In the opinion of this group, at a given atmospheric temperature, the factor having greatest influence is the temperature of the fuel in the fuel system. This temperature is, in turn, influenced by the type of operation the car was subjected to prior to the trouble, by the length of the soak period, wind velocity, and altitude.

Engines of the future, one car designer reported, are being based on fuels of substantially the volatility characteristics now available. Any increase in gasoline volatility, he felt, would result in a corresponding limitation on styling, power, or accessory convenience of the car to come.

Gasoline Sensitivity

As already noted, gasolines of high octane number —such as are needed by high-compression engines —are quite sensitive (see Fig. 3).

This condition is aggravated by the greater use of torque converters, which prevent engine loading at low engine speeds. This shifts the speed of maximum octane requirement from low to high speeds. In addition an increase in breathing efficiency has raised power output for a given engine. This means higher combustion temperatures, and thus a greater knocking tendency.

The automobile industry is doing many things to make engines mild, so they will give a high rating to a sensitive fuel. Included are: better utilization of water jacketing to minimize hot spots, improved carburetion, and improved muffler design. This concentration on attaining mildness is producing results. Even relatively sensitive fuels rate within 0.5 Research octane number in today's engines. A few engines are so mild that they rate fuels even higher than the Research rating.

This trend toward milder engines must be continued, for there seems to be little hope for relief from the fuel end. The trend is toward catalytic cracking and reforming processes. These produce an increase in aromatic and olefin contents of the fuel that is responsilbe for the sensitivity. This gasoline is reported to knock more in the high-speed range than at the lower speeds. However, one discusser suggested that, as far as the customer is concerned, the medium-speed range (under 2000 rpm) is critical, even with automatic transmissions. Thus, the rating of highly sensitive fuels in this range will be most significant.

A method by which the knocking characteristics of automotive engines may be compared in relation

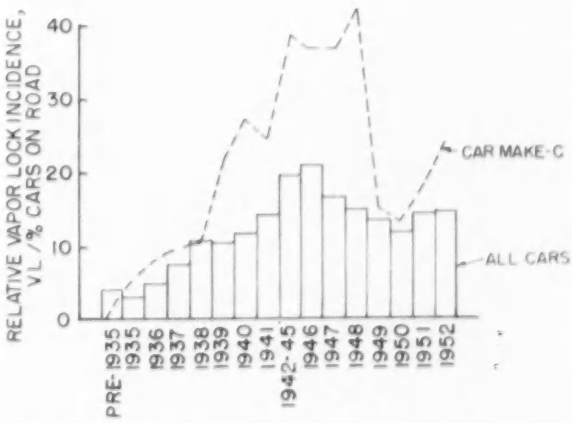


Fig. 2—Vapor-lock incidence by car year. Note that postwar cars are worse than prewar models.

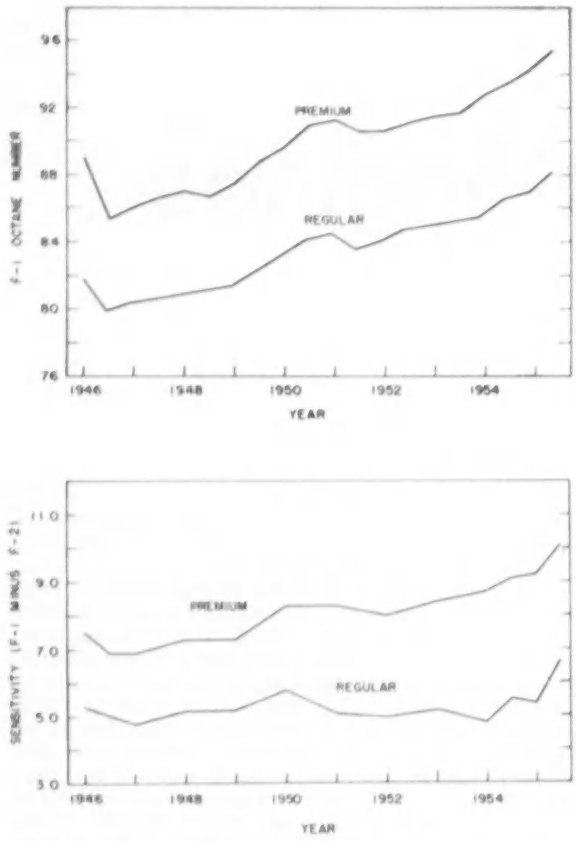


Fig. 3—Trends in antiknock quality and sensitivity of regular and premium gasoline.

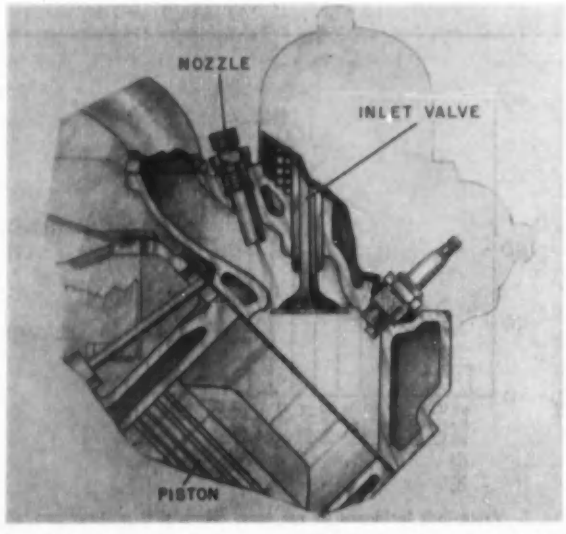


Fig. 4—In the port-injection type of fuel-injection system, fuel is sprayed toward the back of the inlet valve and is carried into the cylinder by the air during the intake stroke.

to the Research and Motor Method engines was described. From this study it appears that two knock test methods must be used to achieve fuel quality control as it is recognized by today's passenger-car engines.

The method shows the relationship of engine octane requirement, fuel sensitivity, and engine severity in a single graph.

The chassis dynamometer is now being used by more than 12 petroleum companies to allow road ratings to be obtained in the lab. It appears that the ratings are comparable to those obtained on the road. Extensive use of these dynamometers should greatly aid the conducting of gasoline surveys and the evaluation of refinery stocks for optimum blending. The saving in time and money is considerable, and the ratings can be obtained without the usual weather and traffic headaches.

Fuel Injection

Carburetors impose limitations on high-speed, full-throttle operation because of the excessive inlet manifold pressure drop at the high airflows required. Also, the hot spot that assists carburetor vaporization under some conditions heats up inducted air and reduces mass airflow. Result is that engine efficiency and maximum output are seriously limited.

Gasoline injection, on the other hand, allows complete freedom in inlet manifold design.

Actually, fuel injection for gasoline engines is not new. The Wright Brothers used it in their aircraft engine of 1903. The real problem has been—and still is—cost.

Described at the meeting was a system with port injection to keep costs down. Even this model, it was speculated, would cost about twice as much as a four-barrel carburetor, if produced in comparable quantities.

In this system, which was reported to work quite well below 5000 rpm, the fuel is sprayed toward the back of the inlet valve, as shown in Fig. 4. From there it is carried into the cylinder by air during the intake stroke. Since 5000 rpm is higher than needed for most automobile engines, it was explained that there is no reason to go to a direct-injection system, with its higher costs.

Advantages listed for gasoline injection include:

1. Increased styling freedom, by allowing lower hood lines.

2. More liveliness because of instant response of the engine to fast or slow throttle movements.

3. Some mechanical octane advantage is gained because of the absence of heat on the intake manifold. These can be used to increase the compression ratio for better output and economy.

4. Spark timing can be advanced considerably without detonation.

5. Full or partial cut-off of fuel flow during deceleration can be accomplished automatically. This will reduce unburned hydrocarbons in the exhaust gas and thus help alleviate smog formation.

6. Some increase in power output from an engine of the same displacement. There was no agreement

as to how much, estimates ranging from 3–5% to 25%.

7. Some gain in economy. On one stock carbureted engine converted to fuel injection, a 5–15% gain in mpg was attained.

8. Allows higher end-point fuels to be used because atomization and distribution are not dependent on induction air. However, one discusser reported a drop in power output when he used such fuels.

9. Allows the use of higher vapor pressure fuels because of the pressurized fuel system, according to one speaker. Higher octane rating of these fuels reduces the tel requirement and promotes cleaner burning and a reduction in combustion-chamber deposits. This point was questioned by another speaker, who has not been able to get any marked improvement in the vapor-handling properties of the fuel-injection system.

If, however, the system does have sufficient flexibility to allow the use of fuel of higher vapor pressure, it will be possible to include butane which is being produced in large quantities in the catalytic reformers being built.

This possible modification in gasoline will have to take place gradually, one discusser warned, because of the millions of cars with carburetors that will be on the road for years to come.

Important items in the design of a fuel-injection system were reported to include:

1. Minimum number of reciprocating parts, which should have minimum mass.

2. Substantial pressure available for atomization at low speed.

3. Ability to feed excess fuel to individual nozzles for cold starting.

4. Low cost.

5. Reliability. Since present carburetors are

This Article . . .

. . . is based on the following papers presented at the SAE Golden Anniversary Fuels and Lubricants Meeting, held at Philadelphia, Pa., on Nov. 9–10, 1955.

W. G. AINSLEY
Sinclair Research Laboratories, Inc.
A. E. CLEVELAND
Ford Motor Co.
"The CLR Oil Test Engine (Progress Report of the CRC-Eld Oil Test Engine Group of the Coordinating Research Council)"

S. E. MILLER
American Bosch Division, American Bosch Arma Corp.
"Automotive Gasoline Injection"

R. V. KERLEY and K. W. THURSTON
Ethyl Corp.
"The Knocking Behavior of Fuels and Engines"

W. P. DUGAN,
Sun Oil Co.
F. T. FINNIGAN
Pure Oil Co.
J. G. MOXEY, JR.
Sun Oil Co.
GILBERT WAY,
Ethyl Corp.
"A Recent Look at Some Problems Related to Gasoline Volatility (Progress Report of the Activities of the CFR-MFD Volatility Group of the Coordinating Research Council)"

P. E. MIZELLE
J. C. PORTER
A. R. RESCORLA
Cities Service Research and Development Co.
"Road Rating with a Chassis Dynamometer"

R. S. SPINDT,
C. L. WOLFE
D. R. STEVENS
Gulf Research and Development Co. Multiple Fellowship at Mellon Institute of Industrial Research
"Nitrogen Oxides, Combustion and Engine Deposition"

P. C. WHITE and A. P. BOYD
American Oil Co.
J. D. DOMKE
Standard Oil Co. (Ind.)
"Future Gasoline for Future Engines"

F. C. MOCK and W. C. SUTTLE
Bendix Products Division, Bendix Aviation Corp.
"Problems of Fuel Injection for Gasoline Automotive Engines"

H. I. WILSON,
R. S. FEIN
J. R. MUENGER,
R. S. WETMILLER,
The Texas Co.
"Road Vapor Lock Incidence"

R. H. ALBRECHT
Standard Oil Co. (Ohio)
KENT HYATT
E. I. du Pont de Nemours and Co., Inc.
R. I. POTTER
Standard Oil Co. (Ohio)
"STOP sludge AND GO clean"

D. T. ROGERS
W. W. RICE
F. L. JONACH
Esso Research and Engineering Co.
"Mechanism of Engine Sludge Formation and Additives Action"

tremendously reliable, fuel injection systems will have to become just as good, in short order.

The great fallacy in much of the thinking about fuel injection, according to one speaker, is the assumption that all you have to do is to get any sort of fuel into the cylinder, and from then on the operation will be just lovely.

Actually, he continued, many of the faults laid to the carburetor and intake manifold have existed within the combustion chamber. Thus, such cures as applying heat or increasing fuel volatility often helped the function inside the cylinder as much as the fuel distribution.

In the compression-ignition engine the air in the chamber is so hot and thick that there is little penetration. When fuel injection is applied to the gasoline engine, however, the spray is carried right across the combustion chamber air space until it strikes a metal wall. Simple experiments show that condensation on the wall may be expected unless the walls are at or above the boiling point of the fuel. On the other hand, if there is initially a dry mixture of fuel vapor and air—as with the carburetor—the walls need only be at the minimum dry vapor temperature for condensation to be avoided. It is to be noted that unvaporized fuel in the combustion chamber is useless.

To attain as good mixing with cylinder injection as with the carburetor takes a bit of doing. It requires injection early in the intake stroke and a certain degree of swirl turbulence.

Thus, this speaker said, he doubted if present fuel boiling points can be changed much by injection. Lower volatility would result in irregular firing, carbon deposits, and crankcase dilution, just as in the past.

Sludge and Other Deposits

One and one-half pounds of sludge may be obtained from a relatively dirty engine. Where does it come from and why does it form? Although sludge is an old problem, it is still forming and it is still misunderstood. Moreover, since current design is in the direction of longer, more powerful engines, there is a chance for more debris from combustion products to escape into the crankcase, if oil capacity is not increased. Thus, the potential engine sludge problem appears to be increasing.

Full-flow oil filters and, where desirable, high-temperature thermostats are helping the matter. Unfortunately, car manual recommendations of 2500–5000-mile oil changes appear to be counteracting some of the good being done, even though the manuals do point out that more frequent changes are needed in cold weather. It seems the average motorist tends to pass over the latter part of the statement—until after he gets in trouble with a thoroughly sludged-up engine.

A series of 50,000-mile field tests with 30 cars driven with a variety of oils ranging from base oils up to and including Series 2 level lubricants pointed to one additive combination that gave superior cleanliness ratings. This oil contained an inhibitor and a large amount of dispersant. Engine parts were almost as free from sludge as those normally found after 1000–2000 miles of operation with a new engine. And this, despite the fact that the tests were run on engines without filters, and oil was changed at 4500-mile intervals. Actually, the parts were clean but covered with dirty oil, with a few light sludge ripples in some spots.

Corroboration of the antisludging action of the high-additive oil (tentatively labeled MS-LD—motor-severe-low-duty, a service classification that it was suggested might be needed if severe low-duty oils become accepted) also came from a taxicab fleet operator. He said that he had had a sludge problem until he turned to oil falling into the MS-LD classification. He reported that it is no longer necessary for his mechanics to drop the oil pan periodically and to clean out the oil lines.

Although running of such extensive field tests is most instructive and helpful in solving the engine deposit problem, it is also expensive and time-consuming. Therefore, it was reported that the CRC currently has groups working on the development of lab engine tests that will be able to duplicate the type of deposits encountered, particularly in moderate-temperature, stop-and-go driving.

The need for low-temperature engine operation studies is also taken into consideration in the newly developed CLR single-cylinder oil test engine. The oil pan is completely encased for gas or water cooling —or live steam heating. In this way a large surface area can easily be cooled or heated.

Recent studies of the mechanism of sludge formation show that the bulk of low-temperature sludge is formed from fuel combustion residues if a high-quality oil is used.

Although it used to be supposed that the sludge was formed in the combustion chamber and blown as solids into the crankcase, this study shows that the lube oil is probably the medium through which the deposit-causing agents from the fuel travel to form engine deposits. When they enter the oil, these deposit-forming agents are low-molecular-weight volatile materials, completely soluble in mineral oil. Favorable conditions exist in the oil for oxidation and polymerization reactions—acids, oxygen, emulsifying catalysts, and promoters, such as metals and metal salts, oxides of sulfur and nitrogen are all present to convert the oil-soluble products into insolubles. Thus, it is clear that an inhibitor in the oil prevents sludge formation by controlling sludge-formation reactions from taking place.

Several investigators reported the presence of nitrogen in sludge. One even went so far as to say that they have found no crankcase deposits that did not contain significant amounts of nitrogen, no matter what the operating conditions were.

Although both fuel and oil contain nitrogen, it appears that the nitrogen comes from the air which, during combustion, forms nitrogen oxides. These oxides then react with unsaturated fuel constituents to form products that play an important part in the formation of these deposits.

It was concluded that appreciable nitric oxide is formed in engines operating at normal spark timing with lean mixtures, the amount depending most directly on the load applied. There appears to be little hope for reducing them from changes in engine conditions, since optimum economical operation seems to be in the range of high nitrogen fixation. Moreover, at the low temperatures characteristic of average driving, it appears that lean mixtures, with a consequent high nitrogen oxide content, contribute must to the formation of varnish.

Truck and Bus Experts Refine the Art of

Preventive Maintenance

At SAE Transportation Meeting, St. Louis

Two new concepts in preventive maintenance were aired at the SAE Golden Anniversary Transportation Meeting held Oct. 31–Nov. 2 at the Chase Hotel in St. Louis.

1. One was that the best basis for the spacing of inspections depends on the type of service the vehicle performs. Straight mileage is best for some fleets. Others should be put on a mileage-time basis. Still others thrive on dated inspection.

2. The second concept—termed "clinical inspection" for want of a better term—is that with modern integrated maintenance instrumentation it's possible and profitable to check an engine's condition without tearing it down.

Besides these new ideas on preventive maintenance, the Meeting brought out information on a variety of other ideas and products. For example:

A differential interconnecting the turbine, compressor, and output shaft of a gas turbine powerplant enables the turbine to operate at speeds where it is most efficient, while the output shaft rotates anywhere in the wide range of speeds the vehicle may demand.

Willys is developing a mechanical substitute for the Army mule to carry infantrymen's gear. It looks like an enlarged version of a child's wagon but its 25-hp engine and four-wheel drive enable it to cover under its own power almost any terrain a man can traverse.

New tire cord materials run cooler and resist wear better. Tiny slashes cut or molded into tire treads improve traction.

Provision for safety belts in 1956 models of passenger cars will encourage their use and give us statistics on which to evaluate them, it is hoped.

Scheduling Preventive Maintenance

How to schedule preventive maintenance checks was debated in technical sessions, committee meetings, and extra curricular gatherings for much of the three-day meeting. The consensus seemed to be that **the basic consideration must always be mileage.**

Some fleets, like Consolidated Freightways, whose trucks are engaged chiefly in over-the-road service find mileage alone the best basis. Other fleets find they need to put at least the lubrication and the inspections in the "B" maintenance check on a mileage-time basis. That is, the check is performed after completion of so many miles or a certain period of time, whichever comes first. The reasoning advanced was that a city delivery truck that covers only 600 miles in a month needs lubrication attention once a month, despite its low mileage.

The trucks the Willett Co. operates in Chicago, and the Atlantic Refining fleet are among the users of mileage-time schedules, it was explained.

Still other fleets operate so regularly over their routes that operators can translate miles into time and schedule maintenance checks by dates. When an operator can predict his work this way, Warren Taussig brought out in presenting his paper, he can put a tolerance of a day or two on his dates and arrange an even flow of work through his shop. The Burlington Lines truck fleet uses a date system for these reasons. Besides, scheduling by date makes it easy to tell outlying shops when to make checks and to keep track of whether they do make them on time.

Most fleets stick to a mileage or mileage-time

SMALL ELECTRICAL MODEL simulating a differential gas turbine, described by David Hutchinson (center), attracts post-session crowd. Gears visible at end represent the differential interconnecting turbine, compressor, and output shaft. Purpose of differential is to permit turbine to operate at high speeds, where it is efficient, while output shaft operates at low speed when vehicle demands it.

basis for their "C" or more extensive, less frequent preventive maintenance check, discussion disclosed.

It was clear that the "B" and "C" checks as outlined in the SAE Recommended Practice on Preventive Maintenance and Inspection Procedure are still the basis for the procedures used by many fleets. However, most fleets have found it feasible to extend the maintenance intervals. This fact was brought out in a meeting of the group working on a revision of the Recommended Practice, the Preventive Maintenance Subcommittee of the SAE Transportation and Maintenance Technical Committee.

Subcommittee members recalled that the Recommended Practice was originally formulated during World War II in cooperation with the Office of Defense Transportation to help small fleets preserve their equipment. The Subcommittee intends to revise the SAE document to reflect the extensions in maintenance intervals made possible by postwar improvements in component design, lubricants, and materials.

Maintenance experts were enthusiastic over electronic ignition analyzers, compression gages, and other shop inspection equipment. As Emil Gohn of Atlantic Refining expressed it: "Originally preventive maintenance relied on averages. Now instruments make it possible to treat each engine as a unit."

The general sentiment was that if an engine is operating sweetly when the schedule calls for an inspection, it's a mistake to tear the engine down. The wiser practice is to check the engine with instruments and leave it alone if they indicate it's as healthy as it seems. This kind of inspection is better for the engine, and it saves labor.

If the instruments show an engine has an ailment, their precise diagnosis saves the mechanic's time. In these days of high labor costs, it's cheaper to locate engine problems by instrumentation than to tinker, E. C. Paige of Ethyl pointed out.

Noting that instrumentation now available for maintenance use is about the same as that manufacturers use to develop vehicles, Paige warned maintenance men not to try to use it to make a "hot rod" out of equipment intended to do the work of a truck. True, you can get more performance by cheating on the settings recommended by the manufacturer—but only at great sacrifice in life, he said.

Maintenance men who have already invested heavily in instrumentation counseled that you get good results from it only if you train your mechanics thoroughly in its use. Otherwise you get faulty indications and incorrect interpretations. Eventually all you have is an expensive dust collector.

While most of the discussion of instrumentation centered on console-type, special-purpose units, the more basic measuring devices were not overlooked. Walter E. Davis of the Cleveland Transit System told how his mechanics use a portable surface pyrometer to check cooling system components. They also check condition of fuel injectors on two-stroke diesels by measuring exhaust outlet temperatures. He suggested, too, that pyrometers would help in checking the mating of dual tires.

There's one piece of instrumentation operators expressed need for— a device to measure brake system lag time. As it was explained in a meeting of the SAE Transportation and Maintenance Technical Committee: The decelerometer checks the end-product, stopping distance. The pyrometer indicates energy absorption by the brake lining. The pressure gage measures air pressure. The missing measurement is lag time.

If you could measure lag time, you could track brake trouble to its source in plumbing, lining, or other location.

Another thing fleet operators would like is a method for checking brake diaphragms. Often brake diaphragms show no visible signs of deterioration before failure. Yet there is no non-destructive test for measuring the life left in them. This is the operators' problem.

It was revealed that one large West Coast fleet accomplishes diaphragm checks by setting each brake to emergency each week and charging the brake chamber with air from a shop compressor to a pressure beyond what the driver can exert. But this method is feasible only where each axle has its own emergency relay valve.

If the Interstate Commerce Commission decrees that braking systems of combinations be equipped axle by axle with emergency relay valves, then this West Coast method of diaphragm testing may serve. But if the American Trucking Association's counter-proposal that tractors and trailers be equipped unit by unit with the valves prevails, another method of checking diaphragms will be desirable.

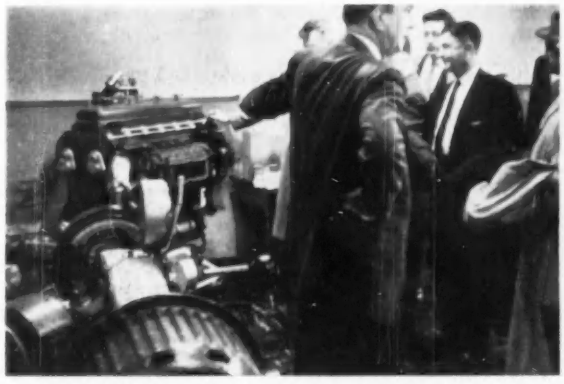
Carl Lindblom of International Harvester noted later that the Automobile Manufacturers Association has announced a new brake system allowing the driver of a truck-trailer combination to make at least one controlled stop after the regular service brake system has failed. The new system was developed cooperatively by vehicle and brake manufacturers and vehicle operators.)

Brake diaphragms last longer, it was agreed, if compressors are maintained so that no oil gets into the compressed air. Keep brake air as clean as you can and use the new neoprene diaphragms, was the advice given.

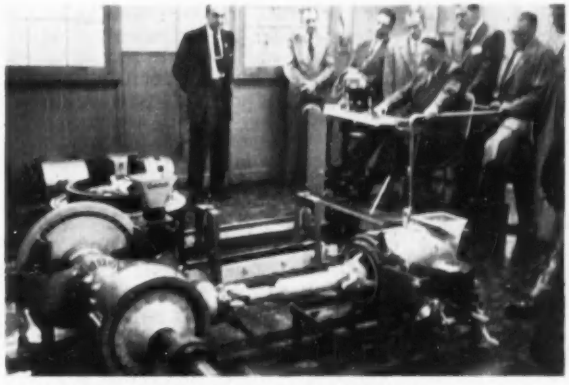
Running as an undercurrent through all talk of maintenance practices was a caution against overmaintenance. Julius Gaussoin of Silver Eagle truck lines voiced the apparent feeling of many when he commented: "It doesn't pay to maintain a vehicle

CONTINUED ON PAGE 68

Meeting Participants Tour Bus and Trolley Shops

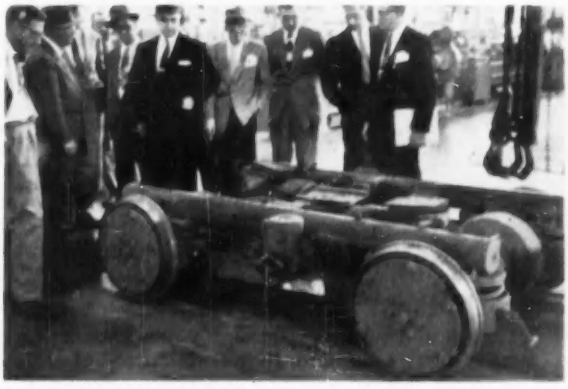


ON TOUR OF ST. LOUIS PUBLIC SERVICE CO.'S SHOPS, Meeting participants see cutaway engine and other cutaways used to teach student operators how driving practices affect vital parts of $23,000 bus. In front of engine are cutaway wheel brake, differential, and axle.



RAIL STREETCAR WHEEL AND BRAKE (left foreground) and motor (right foreground) are used to teach future operators. Edward Allerdissen demonstrates at control panel mockup. Men at left are Burns Franklin, training supervisor, and John Balducci, who has charge of bus shops.

METAL SPRAYING builds up worn shaft, which otherwise would have to be discarded. Company does work like this for its own fleet of 1020 buses plus jobs for other operators throughout Midwest. Facilities include paint and upholstery shops, as well as complete engine overhaul plant.



SPARE STREETCAR BOGEY draws attention of truck and bus experts as it stands ready to serve as replacement on one of St. Louis Public Service Co.'s more than 200 streetcars. In background is an array of machine tools, some used to make parts no longer available from manufacturers.

Disclosures

Made at the Transportation Meeting included:

Differential Gas Turbine—This type of powerplant as conceived by David W. Hutchinson of The Turbex Corp. of Mamaroneck, N. Y., makes output shaft speed a function of the *difference* between turbine and compressor speed. Therefore output shaft speed can vary over the wide range demanded by ground vehicles without throwing turbine speed out of the near-design speed range where—and only where—it is efficient.

This is accomplished by a differential interconnecting turbine, compressor, and output shaft.

The differential also provides high power for accelerating the compressor when it's most needed—that is, while the output shaft speed is low.

No such powerplant has yet been built. But Hutchinson has computed its estimated performance from that of aircraft powerplant components.

Mechanical Mule—Willys has developed a new kind of vehicle to carry small weapons and infantrymen's gear over all kinds of terrain. Briefly it's a platform about 40 in. wide and about twice that long set above four wheels. The whole wagon is only 27 in. high. It weighs 750 lb and can transport 1000 lb. Because of the vehicle's four-wheel drive, all of the weight is available for traction.

The driver can ride on an easily set up folding seat on the platform. Or he can walk beside the vehicle. Or, by tilting the steering wheel downward and backing the vehicle, he can guide it while crawling after it.

A 4-cyl, 25-hp aircooled engine drives the vehicle at any speed from 1 to 25 mph. On a reasonably good road, the vehicle gets 18 mpg of fuel.

In a movie shown following presentation of a paper on multi-wheel drive vehicles by H. C. McCaslin and G. W. Scharbuck of Willys, the Mechanical Mule climbed readily up 70-deg or steeper hills in low gear. It also ran through a swamp in water over 1 ft deep.

So far, five units have been built for demonstration to the Army. Quantity production will depend on military approval.

Tire Siping—Inflicting tiny cuts or sipes on tire treads increases their traction on ice and snow, A. H. Easton of the University of Wisconsin showed. Baldwin revealed that Firestone is already producing passenger car tires with molded-in siping, and siped truck tires are on the way. Also, dealers will sipe tires with a special siping knife, if the customer requests it, he said.

Siping does not appreciably decrease tire mileage, Baldwin continued. He theorized that this might be due to a relaxation of tread tension, lower temperature build-up, and shorter stops.

Another discusser commented that sipes show slight extra wear on their leading edges.

New Tire Cord Materials—For impact resistance you can't beat wire-cord tires, L. L. Baldwin of Firestone revealed. They're being used now on buses and on trucks hauling slag and on a few trucks operating into garbage dumps.

Tire manufacturers aren't promoting wire-cord tires extensively now because the wire is scarce. Even to meet current demand, they've had to buy wire in the foreign market.

Wire-cord tires offer extra safety where tires encounter objects likely to puncture other types of tires. But wire-cord tires are currently so expensive that they offer no savings in operating costs.

With wire-cord tires, it's even more important than usual to maintain proper inflation. Otherwise repeated flexing breaks the wires, and they snap inward, piercing the inner tube.

Nylon-cord tires are far superior to rayon-cord tires for trucks operating over turnpikes, according to George M. Sprowls of Goodyear. Nylon tires can operate at sustained high speeds without ever suffering the heat blow-outs that rayon tires do, he said.

He reported also that nylon tires don't seem to support combustion to quite the extent that rayon tires do. Sprowls showed a movie illustrating that with externally ignited tires, nylon tires could be extinguished faster and with less dry-chemical extinguishant than rayon tires. However, Sprowls agreed with Battalion-Chief Robert Ely of the San Diego Fire Department that it's chiefly the rubber that burns.

Ely pointed out that the dry-chemical extinguishant puts out the fire by keeping away oxygen. But, he reminded the audience, once oxygen is available again, a tire will rekindle if it's above its ignition temperature. Charles Hoffmann, Jr., of the staff of the American Trucking Associations noted that a hot tire is almost impossible to extinguish. As a result of tests, ATA recommends that in case of tire fire on the road, the driver try to control the fire with a dry-chemical extinguisher, remove the tire, roll it to the side of the road, and let it burn.

In-service tire fires result only from extreme abuse, Hoffmann said. With a 19,000-lb axle load, ATA found it had to run dual tires with one tire flat and the other only partially inflated to start a tire fire. When fire did result, it started in the tube and flap, not in the carcass, ATA tests showed.

Nylon tires "grow" in use (due to centrifugal force) a little more than rayon tires do, Baldwin said. Therefore, tread cracks are not so damaging in nylon tires. E. B. Ogden of Consolidated Freightways, a company which recaps its own tires at half the cost of having it done outside, had just previously warned that if cracks run long enough to let stones and road debris work into the cord, the tire isn't worth recapping.

Safety Belts—We really can't tell yet whether or not safety belts are as good as their proponents claim. But we'll never know unless we have some experience with them. Our wisest course of action, it was indicated, is to promulgate the best standards we can, fabricate belts to those standards and install them on vehicles. Then we can compare statistics on accident injuries sustained by car occupants wearing safety belts and not wearing belts.

Biggest hazard to the program was seen by Dr. R. A. MacFarland of the Harvard School of Public Health as the likelihood that of the 140 or more belts now on the market, some are inferior. These inferior belts could prejudice statistical results against belts, he pointed out.

In commenting on harness-type belts, Roy Haeusler of Chrysler reported that there is some evidence that they result in neck whiplash, which can inflict severe permanent injuries. One solution would be high seat backs to support the head on the rebound in case of sudden sharp deceleration. But this would, of course, interfere with rear-view-mirror vision.

in excellent condition until it's obsolete." When it doesn't cost any more to buy a new vehicle than to patch the old or damaged vehicle, buy the new one, he advised. It's good for the nation's economy, and it gives you the benefit of advances in technology.

The place to start in selecting a new vehicle is with the SAE Truck Ability Prediction Procedure, (as outlined on pages 958–963 of the 1955 SAE Handbook and in SAE Special Publication SP-82), declared Robert Cass of the White Motor Co. Know what your loads are likely to be. Survey your terrain. Decide what speeds you want to maintain. Then use the SAE procedure to figure out what power you need, Cass urged.

He told also of one truck purchaser who bought a 10-speed transmission but actually needed and used only three of those gear ratios. The result was that those gear sets wore out prematurely and the whole transmission required unnecessarily frequent repair and early junking. If the purchaser had been more aware of his terrain, he would have known he needed only a simple transmission.

Discussion brought forth the suggestion that in figuring power needed, operators calculate it at legal limit speed and $\frac{1}{8}$ or $\frac{1}{4}$% grade. Those conditions are easier to explain to management and probably more realistic than the conventionally used 20 mph and 4% grade.

Once you've bought a vehicle, it pays to show the driver a little about how it works so that he appreciates the damage that bad driving practices do, W. W. Vandercook of F. J. Boutelle Driveaway Co. pointed out. He reported that driver education plus incentive systems for both drivers and mechanics had saved his company thousands of dollars.

Several score of Meeting participants saw for themselves how the St. Louis Public Service Co. shows drivers the results of proper and improper operation. In the company's driver training building, they viewed a bus rear axle with differential and brake. Cutaway sections reveal to student drivers what happens when gears and brake linings are abused. Other cutaways give students insight into other portions of bus and trolley anatomy.

The company was host to groups of SAE members and guests on three afternoons. Not only did they see the driver training setup supervised by Burns Franklin. But they also spent an hour and a half touring the company's extensive maintenance facilities under the guidance of John Balducci, supervisor of bus maintenance, and Edward Allerdissen, superintendent of rail streetcar maintenance.

This Article . . .

. . . is based on the following papers presented at the SAE Golden Anniversary Transportation Meeting, held at St. Louis, Mo., Oct. 31 to Nov. 2, 1955.

L. L. BALDWIN
Firestone Tire & Rubber Co.
"Tire Designs—Present and Future"

G. R. BEARDSLEY and A. A. CATLIN
International Harvester Co.
"International Harvester Co.'s Approach to a V-8 Engine Program"

G. M. SPROWLS
Goodyear Tire & Rubber Co.
"How to Make Your Tires Help Your Business"

ROBERT CASS
White Motor Co.
"Vehicle Components and Maintenance"

A. H. EASTON
University of Wisconsin
"Progress in Tire Traction"

W. W. SQUIER
Sun Electric Co.
"Instrumentation in Fleet Maintenance"

W. E. DAVIS
Cleveland Transit System
"Clinical Inspection of Motor Coaches"

H. C. McCASLIN and G. W. SCHARBACK
Willys Motors, Inc.
"Four-Wheel Drive Vehicles, Present and Future Uses"

R. W. BOLAND
Joseph Weidenhoff, Inc.
"A Fresh Approach to Ignition Analysis"

E. B. OGDEN
Consolidated Freightways, Inc.
"Fleet Operator's Experience with Recapping and Repair of Tires"

W. A. TAUSSIG
Burlington Truck Lines, Inc.
"Streamlined Maintenance Cuts Costs"

W. W. VANDERCOOK
F. J. Boutell Driveaway Co., Inc.
"The Driver and His Influence on Vehicle Maintenance"

H. A. GRENERT
Cincinnati, Newport and Covington Street Railway Co.
"Clinical Inspection Methods"

TRANSPORTATION

Meeting Hits New High

TOP motor vehicle transportation men from both Atlantic and Pacific Coasts came together in mid-continental St. Louis to mingle with their fellows at SAE's most successful-to-date Transportation Meeting Oct. 31–Nov. 2. Attendance totalled 424. (See page 63 for report of the meeting's technical developments.)

T&M Vice-President Robert Gardner came from Washington, D. C.; T&B Vice-President R. C. Norris from Seattle in the State of Washington. Both were members of the General Committee responsible for the meetings arrangements and operation headed by St. Louisian M. C. Alves as chairman and St. Louisian A. H. Blattner as co-chairman. St. Louis Section Chairman C. R. Feiler was also a member of the General Committee, as were T&M Vice-chairman for Meetings Murray K. Simpkins and T&B Vice-chairman for Meetings S. J. Tompkins.

Three St. Louis Section men, functioning as a Committee on Arrangements for both the Transportation and the Diesel Engine meeting, got high praise for their effectiveness. This group consisted of W. E. Williamson, who was Dinner Chairman; A. A. Hazell, who was Chairman; and O. J. Lindell, Reception Chairman. George C. Vahrenhold had charge of publicity.

Part of the welcome extended SAE members and guests was an invitation to tour the general automotive shops of the St. Louis Public Service Co. on Tuesday, Wednesday, or Thursday afternoons, Nov. 1, 2, or 3. The dozen men who took advantage of the

M. C. ALVES, general chairman of the Meeting (left), talks over the T&M-sponsored sessions with SAE T&M Vice-President Robert Gardner (right) and M. K. Simkins, T&M vice-chairman for meetings (center). Alves is with the Union Electric Co. of Missouri; Gardner with the Regular Common Carrier Conference of the American Trucking Associations; and Simkins is managing editor of "Commercial Car Journal."

S. J. TOMPKINS, Chrysler Corp. (left), vice-chairman for meetings of the Truck & Bus Activity Committee, led the development of the T&B-sponsored sessions at the meeting. **A. H. BLATTNER,** Carter Carburetor Corp. (right), was co-chairman of the Meeting and participated as session secretary on the afternoon of the opening day.

R. C. NORRIE of Kenworth Motor Truck Co. is SAE Vice-President for Truck & Bus Activity.

tour on the first afternoon were so impressed with what they saw that word spread, and much larger groups toured the shops on the two following days.

A total of nearly 100 heard Burns Franklin describe the company's training programs for bus drivers and trolley motormen. The groups also toured the bus shops with John Balducci, superintendent of bus maintenance, and the rail streetcar shops with Edward Allerdissen, superintendent of streetcar maintenance, as guides.

The meeting consisted of six well-attended technical sessions and participation with the Diesel Engine Activity in a joint dinner. General Chairman M. C. Alves opened the sessions with a brief address of welcome.

At the first technical session, SAE Past-Vice-President for T&M H. L. Willett, Jr., was chairman and R. H. Brundige, Columbia Terminals Co., was secretary.

At the remaining five sessions the chairman and secretaries were: L. B. Read, Carter Carburetor Corp., chairman, and A. H. Blattner, Carter Carburetor Corp., secretary; R. S. Lemen, Be-Mac Transport Co., chairman, and R. B. Cornell, St. Louis Public Service Co., secretary; M. W. Marien, Ramsey Corp., chairman, and J. M. Levon, Ramsey Corp., secretary; R. S. Lemen, Be-Mac Transport Co., Inc., chairman, and O. J. Lindell, Consolidated Forwarding Co., Inc., secretary; P. J. Reese, Wagner Electric Corp., chairman, and E. E. Wallace, Wagner Electric Corp., secretary.

F. A. ROBBINS, Koppers Co., is SAE Vice-President for Diesel Engine Activity.

DIESEL

Meeting Draws 420

WITH technical sessions on Nov. 3 and 4, the 1955 Diesel Engine Meeting got started on Nov. 2 at the joint banquet with SAE's transportation men.

But it was at the technical sessions that the Diesel group's interest and attendance was the most intense. (See page 55 for technical story of the meeting.)

Total registration for the diesel session ran to 420, making this one of the finest SAE diesel gatherings in many years.

A final session devoted to diesel problems of special interest to railroad men emphasized the growth in common interests between railroad and vehicle engineers in recent years. Pointed in the same direction was an informal gathering at SAE President Rosen's invitation of a dozen or so railroad men whose interests have led them to become SAE members, along with a few of their fellow railroaders with diesel interests. Aim of the informal discussion was to insure further knowledge among railroad men of the extent to which their problems are common with those of SAE's diesel-interested vehicle engineers.

Responsible for operating this highly successful 1955 Diesel Engine Meeting was a General Committee headed by L. A. Wendt. Working with him was SAE Diesel Engine Vice-President F. A. Robbins, Diesel Engine Vice-chairman, Chairman for Meetings L. D. Thompson and St. Louis Section Chairman C. R. Feiler.

The meeting was opened on the first day by a brief address of welcome from L. A. Wendt, general chairman of the Meeting.

Chairmen at the five technical sessions were: M. R. Bennett, International Harvester Co.; W. E. Williamson, St. Louis Public Serv-

LELAND A. WENDT, Shell Oil Co., was general chairman of the Meeting. He opened the technical sessions with a brief address of welcome to the visiting engineers.

1905 S.A.E. GOLDEN ANNIVERSARY 1955

L. D. THOMPSON, vice-chairman for meetings of the Diesel Activity, chats with a guest-author from England, Ernest Chatterton of D. Napier & Son, Ltd. Thompson is with Fairbanks, Morse & Co. at Beloit, Wis.

Visiting Fireman Puts Out Fire

AS Battalion Chief Robert Ely of the San Diego Fire Department strode back to his seat after asking a question at the Tuesday afternoon session, Lew Kibbee mentioned to Ely that he smelled smoke.

In the process of sniffing at heating ducts, they noticed a fine curl of smoke rising from an upholstered bench. Ely quickly determined that the fire had eaten a foot or so into the stuffing and laid it open with his pocket knife. Here he shows how the fire was extinguished.

Ely's full title is Battalion Chief-Master Mechanic. He supervises purchase and maintenance of a fleet of 70-some motor vehicles plus several fire boats. He campaigns, too, for national standardization of coupling diameters and threads.

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ice Co.; T. B. Rendel, Shell Oil Co.; M. A. Elliott, Armour Research Foundation; and Wayne Lasky, Gulf, Mobile, and Ohio Railroad Co.

Session secretaries were: A. H. Glasenapp, International Harvester Co.; Ralph Cornell, St. Louis Public Service Co.; W. D. Sims, Shell Oil Co.; E. W. Landen, Caterpillar Tractor Co.; and M. A. Hanson, Gulf, Mobile, and Ohio Railroad Co.

Joint Dinner

END of the Transportation Meeting—and beginning of the Diesel Engine Meeting—was a joint dinner on the evening of Nov. 3.

There Dr. Kenneth McFarland gave another of the scintillating talks with which he has stirred other SAE audiences. . . . SAE President C. G. A. Rosen spoke briefly. Niels C. Beck of Illinois Institute of Technology's Armour Institute came from Chicago to toastmaster the event, which was opened by a welcome from St. Louis Section Chairman C. R. Feiler.

"Light a Lamp"—McFarland

McFarland urged the engineers not to stop with just "service." "Find a way to do your job so that it lights a lamp that will be reflected in other people's eyes," he urged.

"Lamp lighting," McFarland defined as doing the right thing and doing it with finesse. You can do the right thing and still not get any dividends from it, he pointed out, unless you also say the right thing at the right time.

Pleading for a spiritual orientation to life, McFarland reminded his audience that, to keep a light shining brightly, you have to connect it to a major source of power.

"Diesel Renaissance"—Rosen

The program of the meeting, President Rosen said "reveals that we are in a sort of renaissance of diesel engine development." He said in part:

This is symptomatic of worldwide investigations now in process. Much interest is displayed over some of the more basic fundamentals of the combustion process and their resultant influences on performance, wear, and smoke. At long last, after 60 years of semi-confused pursuit—engineers are learning what makes the diesel engine work.

The urge for more power with less expenditure of material reveals new design patterns. The economic status of the railroad locomotive calls for re-examination of power plant potentials.

Twenty-five years ago the railroads needed something better than the steam cycle—they found it in the diesel cycle. Today we need renewed emphasis on lower transportation costs. A large part of the cost of basic commodities is still transportation.

Beware of the lethargic trend of striving for the "harmony of the graveyard." As engineers, we need the spur of economic conflict—of disorderly competition in order to survive.

We would be unfaithful to the tradition of SAE if we were to shy away from exploring the limits of human achievement. It is our inherited and specific duty as automotive engineers to uncover and to develop the full utility of the self-propelled vehicle as a better medium of transportation, whether by land, by sea, or by air, to the end that contributions in service be rendered our fellow men.

In these meetings we are honoring the Transportation & Maintenance Activity, the Truck & Bus Activity, and the Diesel Engine Activity. They, in turn, have honored SAE by preparing outstanding papers of high technical excellence. They have chosen a selected group of speakers who have established a superior quality of meeting. These standards of quality we must continue to nourish and encourage.

Hears McFarland and Rosen . . .

Participants in the program of the Joint Transportation-Diesel Engine Dinner on Nov. 2 were: (left to right) Niels C. Beck, toastmaster; SAE President C. G. A. Rosen; Dr. Kenneth McFarland, the principal speaker; St. Louis Section Chairman C. R. Feiler; and M. C. Alves, general chairman of the Transportation Meeting.

More Engineers Came

to the 1905 GOLDEN ANNIVERSARY 1955 F&L Meeting . . .

. . . than to any other exclusively F&L gathering in the Society's history.

PHILADELPHIA's Bellevue-Stratford was the site of SAE's largest exclusive Fuels & Lubricants Meeting on Nov. 9 and 10. General Chairman of the Meeting John G. Moxey, Jr., reports a total registration of about 650 and adds: "So crowded were the technical sessions, that it seemed as though everybody registered had tried to get into every session." There were standees at every session in th big Rose Garden of the Bellevue-Stratford in Philadelphia, where the meeting was held.

Engine deposits, vapor lock studies, latest antiknock data, and fuel injection were the chief topics attracting the fuel, lubricant and engine men to the sessions. (See p. 58 for highlights of the meeting's technical developments.)

Sharing with General Chairman Moxey in the satisfactions of so outstanding a meeting were SAE F&L Vice-President J. F. Kunc, Jr., SAE F&L Vice-Chairman for Meetings Leonard Raymond Philadelphia Section Chairman G. J. Liddell, and the members

JOHN G. MOXEY, general chairman of the Meeting, receives from SAE President C. G. A. Rosen the plaque expressing the Society's appreciation of his work in directing the arrangements for this meeting. (Similar presentations are now being made by the Society to the general chairman of each National Meeting at the conclusion of his Meeting.)

of Moxey's Committee on Arrangements which included: Josiah French, dinner chairman; F. C. Burk, publicity chairman; J. R. Griffin, Jr., reception chairman; and R. E. Albright, social hour chairman.

A special feature at the dinner on Wednesday evening was a presentation on behalf of the Philadelphia Section to B. B. Bachman, honoring the SAE Past-President as a symbol of the men who have made SAE great during its first 50 years. (See p. 82 under heading of Philadelphia Section for more details.)

SAE Past-President R. J. S. Pigott was toastmaster at the dinner, which was opened with a welcome from Philadelphia Section Chairman G. J. Liddell.

Principal speaker at the dinner was *Wheeler McMillen*, editor of "Farm Journal," whose subject was "Fuels, Fairness, and Freedom." *McMillen* emphasized the benefits of a free economy to both farmers and industry alike—and stressed the major contributions to efficient and modern farming which have been made by automotive engineers.

The technical program which brought extensive discussion as well as high session attendance was focused in four separate sessions. Eleven papers were presented, including two based on work of committees of the Coordinating Research Council.

Session chairmen were all Atlantic Coast engineers, three of them Philadelphia Section men; one from Metropolitan Section. They were: F. C. Burk, Atlantic Refining Co.; B. B. Bachman, Autocar Division, White Motor Co.; R. E. Albright, Socony Mobil Oil Co.; and J. J. Mikita, E. I. du Pont de Nemours.

Session secretaries were: L. J. Test, Atlantic Refining Co.; Leonard Raymond, Socony Mobil Oil Co.; J. S. Trogner, Gulf Oil Corp.; and D. R. Diggs, E. I. du Pont de Nemours.

F&L Vice-Chairman for Meetings Leonard Raymond (left) and SAE Vice-President J. F. Kunc, Jr., (right) led the F&L Activity Committee in development of the technical program which brought out a record attendance.

SAE Past President R. J. S. Pigott (left) was toastmaster at the dinner, where Wheeler McMillan (center) was principal speaker. McMillan is editor of "Farm Journal." Philadelphia Section Chairman George J. Liddell (right) opened the dinner program with a welcome to Philadelphia.

"Stop" and "Go" ...

RAY POTTER, checking over the signal light that, with appropriate sound effects, he used to dramatize the "stop" and "go" in the title of the paper he presented, "STOP Sludge and GO Clean."

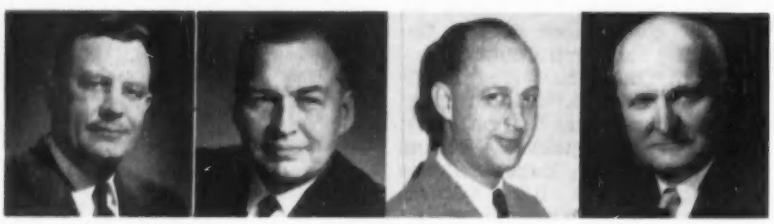
When the light was red, the audience was almost deafened by the sounds of a car screeching to a halt.

When the signal turned green, they heard the engine race and the car roar off in true "jackrabbit" fashion.

Mr. Potter's coauthors are R. H. Albrecht and Kent Hyatt.

About SAE Members

Austin | Wingerter | Gurski | Boegehold



Jennings | Kottmeier | Hegner | James

A. E. JENNINGS has become vice-president in charge of sales for the Automotive Division, Canadian Car & Foundry Co., Ltd., Montreal. He was previously sales manager of the division.

Jennings is the 1955–1956 SAE Montreal Section chairman.

LESLIE H. KOTTMEIER, formerly sales manager of the Aircraft Division, has been appointed vice-president in charge of sales for that division.

A. B. HEGNER has been named assistant factory manager of the Stratos Division, Fairchild Engine & Airplane Corp. He was production manager of Fairchild Engine.

Hegner has been associated with the development of the SAE Aeronautic Production Forum in New York since its inception in 1953. He was general chairman of the 1955 Aeronautic Production Forum and is a member of the Executive Committee for the '56 Forum.

SAE Past-President WILLIAM S. JAMES on January 1 will establish a consulting engineering business with headquarters in Detroit. One of his clients will be the Fram Corp., of which James has been a vice-president since 1948. He was in charge of Fram's research and engineering department.

Formerly chief engineer of Studebaker Corp. and in charge of research at Ford Motor Co., James has been responsible for a variety of important technical developments and has been the author of many papers read before SAE and other engineering bodies.

James has been an active contributor to SAE technical committee progress both before and after his term as SAE President in 1944.

ROY B. LIGGETT has joined the Standard Forge & Axle Co., Montgomery, Ala., as sales engineer. He had been vice-president of Palmer Equipment Corp., Louisville, Ky.

RAYMOND I. POTTER, formerly with Standard Oil Company (Ohio), has joined the engineering staff of the Ford Motor Co. as supervisor of the Fuels and Lubricants in Dearborn, Mich.

Potter was chairman of the SAE national Membership Committee for 1949–1950. He was also chairman of SAE Cleveland Section in 1951–1952. His committee work has included service on 10 committees of the Coordinating Research Council.

EDGERLY W. AUSTIN, general manager of Timken Roller Bearing Co.'s Automotive Division since 1928, retired on November 1.

Austin started with Timken Roller Bearing in 1919 after service in the U. S. Army. He started as a field representative, helping to open the first Detroit office of the company on November 1, 1919.

In 1923, he opened the Cleveland office and became Eastern Division automotive sales manager. He returned to Detroit in 1926 as assistant general manager of the Automotive Division.

The board of directors has announced that Austin will remain with the company in a consulting capacity at the Detroit office.

Austin was chairman of SAE Detroit Section in 1942–1943.

ROBERT G. WINGERTER, assistant general manager of the Automotive Division for four years, has assumed Austin's position as general manager.

Wingerter joined the company as a sales engineering trainee immediately after graduation from college in 1938. He served successively in the Industrial Division as application engineer and assistant chief engineer before his transfer to the Automotive Division in 1944.

He has been chairman of company representatives in SAE Detroit Section for the past two years, and will be serving on the SAE Public Relations Committee for the term of 1956–1960. He also has the special distinction of being SAE golf champion for three successive years, from 1952 through 1954.

JOSEPH GURSKI has been appointed assistant manager of Ford Motor Co.'s Manufacturing Research Department. He had been supervisor, materials and processes for Ford and has been active in chemical and metallurgical materials and processes at Ford since 1934.

Gurski is currently vice-chairman of the SAE Iron and Steel Technical Committee and the SAE Nonferrous Metals Committee. He has been Meetings vice-chairman of the Engineering Materials Activity for two years and is now on the Governing Board of the Detroit Section.

ALFRED L. BOEGEHOLD has been awarded the American Society For Metals' 1955 Gold Medal "in recognition of his great versatility in applying science to the metal industry." Boegehold is assistant to the vice-president in charge of the General Motors' research staff, Detroit. The award was made at the society's annual dinner at Philadelphia.

T. H. SPENCER is now Peoria plant metallurgist for Caterpillar Tractor Co. With Caterpillar for 19 years, he was formerly manager of the Heat Treat Division.

CARL H. MEILE has been appointed chief engineer of engineering research, International Harvester Co., Chicago. He has been with the company since 1950 in Fort Wayne Motor Truck Engineering. Meile recently graduated from the Oak Ridge School of Reactor Technology in Tennessee, where he spent a year under the auspices of International Harvester.

ALFRED J. POOLE retired in April, 1955. He had been manager of sales and service of diesel products, Scintilla Division, Bendix Aviation Corp., Sidney, N. Y. Poole had served with Bendix since 1931.

A member of SAE since 1910, he was vice-president representing Diesel Engine Engineering in 1932. He was also a central figure in the development of the first Diesel Engine Activity.

JOSEPH H. SHIRAR has become transportation superintendent at the Naval Air Station, Los Alamitos, Long Beach, Calif. He is senior civilian in charge of the Transportation Division.

JOSEPH A. TORCH has announced the formation of the Joseph Torch Sales, Montreal, Quebec, Canada. The company was formed to provide personal representation for those companies now supplying replacement parts to the bus industry, without the benefit of this service. Prior to forming his own company, Torch was in charge of Montreal sales for Joseph Robb & Co., Ltd.

FRANK E. STOREY has become associated with the Ford Motor Co., Mercury Division, as assistant chief engineer. Storey had been chassis engineer, Studebaker-Packard Corp., Detroit.

GEORGE C. PRILL has joined Capitol Airways, Inc. as vice-president of maintenance and engineering, located at Nashville, Tenn. He had been technical director, Air Coach Transport Association, Inc., Washington, D. C.

FREDERICK C. RUSSELL's book "Fred Russell's Car Care" is now being offered in a new and revised edition. It has been written in such a way that the average motorist can understand even such complicated features as the new spring suspension system, power steering, and improved automatic transmissions. There is specific information on tubeless tire care and much that is helpful in avoiding winter and summer car troubles.

V. W. FRIES has been appointed chairman of the board of directors and chief executive officer of the White Sewing Machine Corp. He had been executive vice-president, White Motor Co., Cleveland. Fries has been a director of White Sewing Machine Co. since June of 1954.

Doctor of Engineering

ALEXANDER KARTVELI, vice-president and chief engineer of Republic Aviation Corp., was honored with a Doctor of Engineering degree, Oct. 8. The Polytechnic Institute of Brooklyn hailed him as a "great architect of the air age" whose "imagination has soared aloft" with aircraft he has designed.

Kartveli designed the Republic Thunderbolt and Thunderjet.

Alexander Kartveli

GORDON E. WHELPLEY is now with the mechanical engineering department of Corning Glass Works, Corning, N. Y. He had been senior product engineer, Aircraft Research & Engineering Division, Houdaille-Hershey Corp., Highland Park, Mich.

H. N. BOGART has been appointed manager of manufacturing research at the Ford Motor Co. His most recent assignment was as assistant to Gosta Vennerholm, recently deceased.

Following graduation from Michigan State College in 1937, Bogart joined Ford. He worked in the field of metallurgical development, planning such developments for production. He is the author of several articles in the metallurgical field.

PORTER WRAY has recently been promoted to assistant chief metallurgical engineer for U. S. Steel Corp. He has been serving as metallurgical engineer, Alloy Steels, for the corporation.

Wray has been active in SAE Iron & Steel Technical Committee work, serving as chairman of Panel A—Steel Producers.

NORTON J. NICHOLS, formerly plant metallurgist, Saginaw Steering Gear Division, GMC, Saginaw, Mich., is now with the Walmil Co., Pleasant Ridge, Mich., as sales engineer.

J. H. KINDELBERGER, chairman of the board of North American Aviation, Inc., announces the establishment of Atomics International as a separate division to handle the company's nuclear engineering and manufacturing operations. The new division will soon occupy a new building in the Canoga Park section of San Fernando Valley, Calif.

MELVIN D. KILMER has been named vice-president by J. C. Carter Co., Costa Mesa, Calif. He had been sales manager.

ROGER HENRY WILLIAMS has become service representative for Caterpillar Tractor Co., Peoria, Ill. Williams had been staff engineer, service engineering, for Caterpillar.

DANIEL H. SMITH has become process engineer for the Ford Motor Co.'s Parts and Equipment Mfg. Division, Sandusky, Ohio. Smith was previously process engineer at the Ford aircraft plant in Kansas City, Mo.

EMIL J. VODONICK, previously staff engineer to the administrative engineer, Sundstrand Machine Tool Co., Rockford, Ill., is now staff engineer to the director of production and purchasing at Sundstrand.

Correction

On page 85 of the October issue of SAE Journal, it was erroneously stated that **CHARLES W. KYNOCH** was consulting engineer on all transportation problems for the Wetmore-Hodges Co., now Locomotion Engineering, Inc.

At the time of his death, Kynoch was employed by Wetmore Hodges and Associates Inc. as executive engineer, and was in no way affiliated with Locomotion Engineering, Inc. The latter organization has no connection with Wetmore Hodges and Associates Inc.

Somebody Told Me

by R L Sackett

GLEN C. RIEGEL, Caterpillar's chief metallurgist, a past SAE V-P of Engineering Materials and Past-Chairman of ISTC, retired August 31. Glen bought a place in western North Carolina near Ashville. That may make him a neighbor of **C. EMMETT ZWAHL**, chief metallurgist of Chevrolet, who is due to retire the end of this year and has himself a place in the same locale.

STM

That will be two additions to our rapidly growing ISTC Alumni Association. **ED STILWILL** was the last new ISTC Alumnus. He retired a few months ago as chief metallurgist of Dodge Division, Chrysler. Ed is also a past ISTC Chairman. McInerny Spring Co. of Grand Rapids has Ed on a consulting basis with a couple of days a week work.

STM

WALTER JOMINY, Chrysler, and **JOE GURSKI**, Ford, made their first trips to Europe in May and June to attend the International Metals Show and do a little business and personal lookseeing. Walter got to see his father's old home near Zurich, Switzerland, and Joe says that Germany puts on the best meetings, France the best plant tours, and England the best cocktail parties.

STM

DR. E. S. ROWLAND, chief metallurgical engineer of Timken Roller Bearing Co., had his residence at Arden House, Harriman, N. Y., this fall while he pursued special study in "Advanced Industrial Management"—a Columbia University course.

STM

Oh!, for the life of a retired engineer, a la **NEWTON F. HADLEY** who finished at Chrysler Corp. last spring.

Summer address—6839 So. Riverside Drive, Marine City, Mich. That's right on the beautiful blue St. Clair River just below Lake Huron.

Winter address—719 17th Ave. So., Naples, Florida.

Newt was chief engineer of Plymouth from its inception in the late 20's until 1953. Then he transferred to Central Engineering staff.

STM

STANLEY WHITWORTH has been an industrial consultant since he retired as vice-president of manufacturing at Studebaker back in 1948. Stan plans to do more of the same later on when he is fully recovered from a recent illness. He's living at 3635 Newhaven Road, Pasadena 8, Calif. Incidentally, he was on hand for the SAE Golden Anniversary Fall Aeronautic Meeting in Los Angeles.

STM

KEN HERMAN, 1955–56 chairman of the Detroit Section (recently made president of Vickers, Inc.) is sporting a new two-engined plane for his personal travel. He's his own pilot.

GEORGE W. FEIL is now with the Studebaker-Packard Corp., Detroit, as advanced chassis engineer. He had been with the International Harvester Co., Fort Wayne, as advanced design engineer.

EDWARD S. GALLAGHER is now manager, aircraft and weapons systems applications, General Electric Co., New York International Airport, Idlewild. Gallagher had been manager of sales for General Electric in Schenectady.

LEONARD GRIFFITH has been named head of the new High Pressure Pneumatic Group of Accessory Products Corp., Whittier, Calif. He was division engineer in charge of Hydraulics and Pneumatics at General Controls.

Carlson

Keown

RAYMOND E. CARLSON, vice-president in charge of sales and a director of Tung-Sol Electric Inc. since 1938, relinquished his sales responsibilities November 30. He will remain active with the company as a vice-president and a member of the board.

Carlson has been active on the SAE Lighting Committee since its formation. He became vice-chairman of the committee in 1930, and has been chairman of the committee since 1941.

GEORGE W. KEOWN, who has been elected a vice-president of the company, has assumed the sales responsibilities.

Keown became associated with Tung-Sol in 1944 and was prominent in the World War II expansion program of the company. In 1946 he became initial equipment sales manager for both the automotive lamp and electron tube divisions of the firm and in 1950 was made general sales manager.

E. VAN VECHTEN, formerly sales manager of Keystone Engineering Co., Los Angeles, has just been assigned to head a products division of Keystone as manager. He has been in charge of the development of the Keylift, a self-contained hydraulic cargo lift designed for the airport handling of air freight, baggage, food servicing, and aircraft engine service.

Lou Walther Kuhn Stratton

NILS LOU has been named works manager for Republic Aviation Corp., Farmingdale, N. Y. He joined the plant in 1953 as chief manufacturing engineer. He has been factory manager since April, 1954.

ROY K. WALTHER has been appointed chief engineer, West Coast division, Trailmobile, Inc. He will head the engineering department at the Berkeley plant.

Walther joined Trailmobile in 1935. He had most recently served as head of development engineering.

WARREN VAN R. GILBERT has been appointed assistant manager of forging sales for Aluminum Co. of America. He will be located at the company's Vernon, Calif. works. For the past year he has been stationed at the Washington district sales office, after assisting the Department of Commerce with mobilization planning since 1951.

ROBERT M. KUHN, formerly transport vehicles design engineer, U. S. Army Ordnance Corps, Ordnance Test Activity, Yuma Test Station, Yuma, Ariz., has joined the Chemstrand Corp., Pensacola, Fla. He is supervisory maintenance engineer.

P. G. STRATTON has joined Drive-Lok Pin Co., Sycamore, Ill., as district sales engineer. He will make his headquarters in Detroit.

Stratton has been serving with Chrysler Corp. as a designer.

ERNEST LLOYD KORB, previously sales manager of wholesale marketing, The Pure Oil Co., Chicago, is now Detroit area manager in charge of marketing operations for the company.

FRANK KOTTMEIER is with the Shell Oil Co., San Francisco, working on industrial products sales. He had been special representative for the Caterpillar Tractor Co., Peoria, Ill.

WILLIAM RUSSELL has been appointed general manager of W. H. Coffin Air Service. His duties will include serving as shop supervisor for Hank Coffin Aircraft as well as assistant to Coffin. Recently, W. H. Coffin Air Service, under the direction of Russell, completed the rebuilding of an old Ryan airplane for use in the motion picture, "The Lindbergh Story."

JAMES J. NANCE, president, Studebaker-Packard Corp., has announced his company will now operate with all Packard and Clipper automotive operations consolidated into a Packard-Clipper division and with Studebaker car and truck operations in a Studebaker division. Managers of each division will administer their respective divisions as separate operating organizations in accordance with corporate policies and programs and provide coordination between divisional operations, corporate departments, and staffs.

(SAE Journal erroneously printed, in the November issue, the words "will not operate" instead of the correct "will now operate" in the first sentence of this announcement.)

Obituaries

WILLIAM F. PIOCH, SR.

William F. Pioch, manufacturing engineering consultant, Ford Motor Co., Dearborn, Mich., died October 3. He had joined Ford in 1912. Previously he had worked for Trio Mfg. Co. and Banta Motor Co. He originally joined Ford as a draftsman.

He had been an SAE member since 1937 and was also a member of the Detroit Federation of Musicians, the Oakland Hills Country Club, and the Detroit Yacht Club.

GOSTA VENNERHOLM

Gosta Vennerholm, manager, manufacturing research department, Ford Motor Co., Dearborn, Mich., died September 8.

Vennerholm had been with Ford since 1924. He joined the company in Dearborn after studying metallurgical engineering at the College of Technology, Dresden, Germany. He had previously obtained a mechanical engineering degree from the College of Technology in Stockholm, Sweden.

His first work for the company was metallurgical supervision and development work. From 1933 until 1938 he was employed by the company in Dagenham, England. In 1938 he returned to Dearborn.

He was an active SAE member and had served as chairman of the Ferrous Casting Committee of the Iron and Steel Committee of SAE's War Engineering Board.

ALFRED MOORHOUSE

Alfred Moorhouse, vice-president and director, Technical Assistants, Inc., Atlanta, Ga., died October 8.

Moorhouse had been a member of SAE for 43 years. At the time he joined he was assistant engineer for the Hudson Motor Co., Detroit. He had been born in Detroit in 1884.

Some of his other company affiliations had been: Michigan Brass & Iron Works, Detroit Auto Vehicle Co., Cadillac Motor Car Co., and Chalmers Motor Co., all located in Detroit.

COL. CHARLES E. BATSTONE

Charles E. Batstone, retired chief of the Air Force Industrial Security Section, Washington, D. C., died September 20. He was buried in Arlington National Cemetery, Arlington, Va.

Batstone served with the Marines in World War I and with Army Aviation in World War II both in North Africa and Southern France. He was also a

Continued on page 80

WALTER P. CHRYSLER's boyhood home in Ellis, Kansas, was dedicated as a memorial last summer. Chrysler was a member of SAE for 24 years before his death in August, 1940—and the deed to the home was presented to the Mayor of Ellis by K. T. KELLER, Chrysler board chairman. He was accompanied to the dedication by SAE Past-President JAMES C. ZEDER, Chrysler's vice-president of engineering.

veteran of the Korean War.

At one time he had been associated with the International Harvester Co., Boston, Mass. branch, as service manager. Later he was associated with the Brockway Co. in the same capacity.

He was recalled to the U. S. Army and served on the Pacific Coast in the Army Aviation Security Division. He was recommended as Brigadier General and the papers of recommendation were on President Harry Truman's desk to be signed when Col. Batstone had to retire because of ill health.

He had been living in Tampa, Fla. since his retirement in 1952.

HUBBARD WILLIAM STEINER

Hubbard William Steiner, manager, tank track sales, U. S. Rubber Co., Fort Wayne, Ind., died July 24. He had been with the company for 28 years.

From 1924–27 he had been with Frank H. T. Potter, Chicago, as manager and engineer; from 1921 to 1923 with Standard Parts Co., Cincinnati, as general manager; from 1919 to 1920 with Trailmobile Co., Cincinnati as chief engineer; and from 1916–19 with Standard Parts Co., Cleveland, as assistant engineer.

LEIGH R. EVANS

Leigh R. Evans, vice-president, Hardinge Bros., Inc., Elmira, N. Y., died suddenly May 1. He had been an SAE member since 1912.

At the time he became a member, Evans was chief engineer for the Russell Motor Car Co., West Toronto, Canada. He received the M. E. degree from Cornell University in 1907 and then joined the H. H. Franklin Mfg. Co., Syracuse, N. Y. He began as foreman of the experimental laboratory for the company. Then he became auditor of costs and chief of the cost department. He was also construction engineer in charge of the drafting department, experimental machine shop and laboratories. He then joined the E. R. Thomas Motor Co., Buffalo, N. Y., as chief inspector and assistant engineer. Still later he was foreman of the machine shop of Ingersoll Sergeant Drill Co., Easton, Pa.

He had been born in Easton, January 27, 1884.

NELSON S. MOSHER

Nelson S. Mosher, sales manager, Alloy Metal Abrasive Co., Ann Arbor, Mich., died recently. He had been active in the Shotpeening Division of the Iron & Steel Technical Committee of SAE and had been chairman of one of its subcommittees.

Mosher had joined Alloy Metal in 1950. Previously he had been with the Chevrolet Division of GMC for many years. He represented Chevrolet on various GMC committees on tools and machines and acted on special assignments and as liaison between Chevrolet plants.

HENRY PLONSKI

Henry Plonski, chief inspector, Peninsular Metal Products Corp., Detroit, died September 22. He had been with the company for 19 years.

Plonski joined Peninsular Metal Products in 1936. Various positions he held leading to chief inspector included: metal inspector, metal polisher, lacquer polisher, assembler, buttwelder, spotwelder, die setter, inspector, foreman of inspection, supervisor of inspection, and assistant chief inspector. He had previously worked as inspector for Bohn Aluminum Brass Corp. and the Gear Grinding Machine Co.

SAM M. HAYS

Sam M. Hays, superintendent of maintenance, Silver Eagle Co., Portland, Ore., died September 18. He had been superintendent of maintenance for the company for the past eleven years.

Previously Hays had been mechanic and foreman for the Pacific Greyhound Line (1926–44); partner of the Great Western Garage (1920–26); and mechanic for the Auto Sales Co. (1918–20).

He was born July 4, 1899, at Boulder, Colo.

GEORGE W. DAGGETT

George W. Daggett, design engineer, Manufacturing Development Division, General Electric Co., Erie, Pa., died from a heart attack, July 29.

Daggett graduated from Cornell University, Ithaca, N. Y., in 1918 as an aviation engineer. He had previously taken correspondence school courses in mechanical, electrical, and automotive engineering.

During World War I he was in the U. S. Army Air Service as test pilot and engine instructor. He held the rank of second lieutenant. Prior to his Air Force service he was factory serviceman for the Baker R & L Co., Cleveland. From 1919–21 he was a partner with his father in their own shop doing general machine design, building and maintenance, and automobile rebuilding. He became assistant master mechanic of the Pennsylvania Railroad Co.'s Mt. Vernon, Ohio, shop. He was president and general manager of the Steelite Piston Corp., Pittsburgh, (his own corporation) developing and manufacturing forged steel pistons (his own patents). Later he was sales representative for Advertisers Exchange, Inc. (1931–39); designer, tools and machines and did equipment rebuilding for Harry L. Daggett Machine Shop, North Girard, Pa. (1939–41); designer and engineer, General Electric Co., Erie, Pa. (1941–43), and production manager, and sub-contract director for Erie Engine & Mfg. Co., Erie, Pa. in 1944. His specialty was invention and design of special machines and devices. He held a number of patents.

E. F. OMAN

E. F. Oman, owner and manager of the E. F. Oman Co., Seattle, Wash., died recently.

Oman had been a manufacturer's agent, establishing distribution for sales and service through established automotive parts and equipment jobbers, from 1922 until 1933 for the following: Federal-Mogul Corp., Detroit; Ohio Piston Co., Cleveland; Chicago Rivet & Machine Co., Chicago; and John C. Hoof Co., Chicago.

In 1933 he established the E. F. Oman Co., distributor for: Mallory Electric Corp., Detroit; Edison-Splitdorf Corp., West Orange, N. J.; Emerol Mfg. Co., New York; and others. From 1942 until 1946 he was with Winslow Engineering Co., Oakland, Calif., doing service and sales work.

Oman was born at Bucklin, Mo., October 28, 1895, and received his education in the public schools of Missouri.

MAJ. F. T. H. BRADLEY

Maj. F. T. H. Bradley, Lublin, McGaughy & Associates, architects and consulting engineers, Washington, D. C. and Norfolk, Va., died October 5 in London.

Before joining Lublin, McGaughy, Maj. Bradley had been consulting engineer with Century Geophysical Corp., Tulsa.

He was a native of Australia and had attended the University of Sydney where he obtained the B.E. degree in Mechanical and Electrical Engineering. After graduation, he joined Watson and White, consulting engineers in Sydney, as an engineering assistant. Later he worked for the Australian Gaslight Co., and as inspector of ordnance machinery for the Australian Military Forces. He commanded Australian Army Ordnance workshops in Sydney.

From 1937–38 he was officer of mechanical engineering for the British Government attached to Woolwich Arsenal and Royal Army Ordnance Corps workshops throughout England. During the following year he was admiralty engineer for the British Government.

From 1940–44 Maj. Bradley was with the Indian Army Ordnance Corps attached to the Royal Indian Navy and the Indian Army Ordnance workshops in Bombay, and Indian Army Ordnance workshops in Calcutta.

SECTIONS

DECEMBER 1955

Smaller Sections On Top In Local Meetings Support

Members of smaller Sections and Groups turn out in greater proportion to support their local meetings than do the members of the larger Sections. This important data has been gathered from Section and Group Budget reports.

Member attendance at meetings last year ranged from 7% of the total Section or Group membership to 71% . . . with 27% the median.

The ten Sections and Groups reporting best support from the members were, in order:

Virginia
Western Michigan
Williamsport
Salt Lake
Alberta
Colorado
St. Louis
Mid-Michigan
Syracuse
Central Illinois

At the average Section meeting, the reports indicate, 72% of those in attendance are members and 28% nonmembers.

THE DEADLINE FOR SAE JOURNAL SECTION NEWS IS THE 12TH OF THE MONTH PRECEDING PUBLICATION.

If the 12th falls on a weekend or holiday, material must be in on the previous workday.

For example, stories and photographs for publication in the March issue must be here at SAE headquarters in New York on February 10. (The 12th is a Sunday.) Therefore, the material should be in the mail by Monday, February 6 at the latest, from most parts of the country.

MONTREAL

A. A. Larkin, Field Editor

Welcome Mat Is Out For All Montreal Speakers

To insure Montreal Section speakers the gracious treatment they deserve, Jack T. Dyment, chairman of the Section Speakers Committee, has drafted a letter to each prospective speaker.

Questions in this letter are tuned to discovering every possible way Section members can make the guest's arrival, meeting visit, and spare time satisfying and pleasant.

Some of the queries included are:

"How and when do you expect to arrive in Montreal? If in the morning, would you be able to have luncheon with some of the members of the Governing Board?"

"Would you like us to make your hotel reservation?"

"We wish you to have a pleasant visit to Montreal, so please let us know if there is anything we can do, such as taking you to visit a particular plant or place."

"It is appreciated that you may have personal commitments or otherwise wish to be on your own either the whole or at least part of the time. Would you prefer, other than previously noted, to be on your own?"

"Do you require a blackboard? An easel? A projector? What kind?"

Speaker's Memo Attached

Dyment has attached to this letter a memo for the speaker's retention. On this memo is listed the date, time, and place. But also, there is included the following:

"If by chance our planned contact for the day goes astray, please phone one of the following:

Chairman, Speakers Committee
Activity Vice-Chairman
Chairman, Montreal Section."

(The names, addresses, and phone numbers of these men are listed next to the above titles.)

Information needed for meeting announcements; press releases, and simply introducing the speaker is sought. He is asked to provide a brief biography and photograph of himself. He is also asked to include a brief review of his talk as he would wish it to appear in the press. If possible, he is asked to provide a copy of his talk for submission to SAE headquarters for possible reproduction in SAE Journal.

Says Dyment as the forms come in, "This form has been most useful in getting us the information we need ahead of the meeting."

MORE SECTIONS

articles appear under Section headings on pages immediately following

Philadelphia

M. K. Simkins, Field Editor

B. B. Bachman Honored by Section

BENJAMIN B. BACHMAN was honored by the Philadelphia Section on Wednesday, Nov. 9, 1955, as the Section's symbol "of the spirit of SAE during its first half century."

John A. C. Warner, SAE secretary and general manager, made the presentation on behalf of the Section—and a plaque, commemorating the occasion, was given to the 1922 SAE President by Philadelphia Section Chairman George J. Liddell. (The presentation was made at the Fuels & Lubricants Meeting Dinner in the Bellevue-Stratford in Philadelphia.)

The Section made the award, according to Liddell, because "at the end of 50 years of SAE, we want to look back and identify the people who have helped make the Society what it is. By recognizing their good qualities, we can attempt to emulate them and continue the good work they started.

"A successful engineer, willing to spend time and effort for the benefit of other professional men in his own field and its related industries is certainly one to be admired, complimented, and copied. . . . We have selected B. B. Bachman as our symbol, in our own Section, of the spirit of SAE during its first half-century."

TWO FAMOUS BENJAMINS met in Philadelphia on Nov. 9 when **BENJAMIN B. BACHMAN** was honored by the Philadelphia Section and was compared to Benjamin Franklin for his qualities of wisdom and understanding. (See accompanying story.)

"Benjamin Franklin" sat beside Bachman at the Fuels & Lubricants Meeting dinner where a presentation to Bachman was made. In real life he is William H. McFarland, who, for some years, has made a career of impersonating the famous Philadelphian. The long silver hair is his own.

THE PRESENTATION by the Philadelphia Section honoring B. B. Bachman was made on the Section's behalf by **JOHN A. C. WARNER**. Section Chairman **GEORGE J. LIDDELL** sponsored and participated in the presentation. (See accompanying story.)

Two Famous "Benjamins"

Noting Liddell's words, Warner began his presentation to Bachman by saying: "This is the Philadelphia story; and I say: "What's good for Philadelphia is good for the whole of SAE." Then he continued:

"Benjamin Bachman, you know, is one of TWO distinguished Benjamins in this community. I mention him in the same breath with Dr. Franklin because the two gentlemen have several important attributes in common.

"WISDOM and UNDERSTANDING are among these attributes.

"On an occasion such as this, it's a temptation to belabor a man's virtues as such. Our earlier hero of Philadelphia listed some 13 of these and kept score on himself as he tried to perfect his character.

"But I assure our guest of honor that we shall not keep tally on how well or how poorly we think he scores according to Franklin's standards of virtue.

"As our President in 1922, as Philadelphia Section Chairman in 1924, as first President of the Coordinating Research Council in 1942, as Chairman of our War Activities Council during World War II, as SAE Treasurer since 1944, you, Benjamin Bachman, have always served SAE with distinction. Whether as captain or as member of the team for 45 years, since your Junior membership started in 1910, you have continued to help us move forward toward better goals.

"You should know that your well-known habit of "doodling" at Council meetings is based on solid precedent. Benjamin Franklin did it too. He makes his confession in these words:

" 'I was at length tired with sitting

there to hear debates which were so often unentertaining that I was induced to amuse myself with making magic squares or circles, or anything to avoid weariness.'

"As I speak for all who know you, Bach, just permit me to say that our deep admiration stems from your warm comradeship, your wisdom, your sympathy, and your generous understanding.

"Our SAE philosopher friend Norman Shidle states this well when he says, 'You lead men's lives to goodness and strength, simply by living that way yourself and letting the world see the fine person such living has produced.'

"This explains why the Philadelphia Section has picked you as their lively and living symbol of the spirit of SAE during its first half century."

So. California

T. E. Achor, Field Editor

3-Point Formula Is Success With Students

"The formula for the success of Student activity is the right combination of effort, interest, and cooperation on the part of:

1. SAE Section officers
2. the Student Committee chairman, and
3. the faculty advisers of the Student Branches.

This combination spells success in organizing an interesting program of speakers for the Student Branch meetings." So says Thomas H. Hardgrove, So. California Section 1955–1956 Student Committee chairman.

The So. California Section of SAE initiated its Student activity program in 1942. During the ensuing years the Section has had 10 different Student Committee chairmen. They served as follows:

1942–43 F. Brint Edwards
1943–44 Norman C. Parrish
1944–45 B. T. Anderson
1945–46 P. R. Kyropoulos
1946–47 P. R. Kyropoulos
1947–48 P. R. Kyropoulos
1948–49 Paul C. Swan
1949–50 T. D. Howard
1950–51 J. W. Sinclair
1951–52 R. F. Labory
1952–53 M. W. Hall
1953–54 M. W. Hall
1954–55 M. W. Hall
1955–56 T. H. Hardgrove

Tom Hardgrove, the present chairman, took over when Mell Hall was transferred to Phoenix, Ariz., and therefore had to resign at the beginning of the 1955–56 term. Tom works for Aerojet-General Corp. in Azusa and was formerly a faculty adviser for the Student Branch at California State Polytechnic College.

Boosting Student Activities

A concerned effort has been made by the Section to boost the Student Branch activities in this area. This has been accomplished by:

1. Partially underwriting the cost of tickets for all dinner meetings up to a limit of 50 Students for any one meeting.
2. Presenting SAE Student banners to each of the Student Branches. These banners are displayed at Student Meetings.
3. Assisting the Student Branches in obtaining qualified technical speakers for their Branch meetings. The SAE Western Branch manager, Ed Rentz, the Student Committee chairman, and other members of the Section Governing Board have been a great help.
4. Holding a joint meeting once a year, at the beginning of the school term, of the Student Committee chairman and the Student Branch chairmen and faculty advisers to discuss their problems and programs for the coming year.
5. Holding periodical meetings of the Student Committee chairman and the various Student Branches throughout the year to offer suggestions and answer questions relative to Society functions.
6. Sending a list of five or six names at the end of the school year to each of the Section Governing Board members with a request that they write a personal letter to the graduating Students assigned to them. This letter extends a personal invitation to apply for SAE membership as a means of maintaning their technical development and contacts with technical people in their field.

These activities are handled by two people, the Student Committee chairman and his assistant. For the 1955–56 season, N. G. Stasinos is assistant chairman. Their efforts cover five Student Branches: Northrop Aeronautical Institute, California State Polytechnic College, California Institute of Technology, Loyola University, and Cal-Aero Technical Institute; also, one SAE Club, the University of Southern California.

Each Student Branch operates independently, having its own Student chairman and faculty advisers. Although the SAE provides recommended speakers and papers, the arrangements for the presentation of these papers are made by the Student chairman of each school.

Mac Short Award

The annual composite meeting of all schools involves the competition for the Mac Short Award.

Each year So. California Section awards the Mac Short Trophy to the student, enrolled in one of the Section's SAE Student Branches, who has contributed the most to engineering during the school year. Each school nominates one eligible student on general scholastic rating, originality in engineering thinking, leadership, resourcefulness, ability to express thoughts, and activity in the SAE Student Branch. From the selections, the Section Governing Board decides the winner of the trophy.

A basic cooperation is established, however, through the group meetings of all Student chairmen and faculty advisers with the Student Committee chairman at the beginning of the school terms.

Tom Hardgrove started by writing to the various schools asking for proposed schedules of Student Branch meetings. He met with the Student chairmen and faculty advisers to discuss their meeting programs for the current year. He is soliciting papers from the various schools for competition in the Mac Short Award and it will be his responsibility to handle all the arrangements for the presentation of these papers to the Section Governing Board in an anonymous manner. He will then present the Mac Short Award and certificates to the participating Students at the Mac Short dinner at the end of our fiscal year. His plans for the future include assisting the graduating Student members to get positions in industry for which they are best suited.

Activity Vital to Students

Tom feels that the Student activity is important to the Students since it gives them a feeling of direct contact with men in a highly technical industry. This is obtained through membership, attendance at the dinner meetings, and through speakers at their individual Student Branch meetings. The goal is to increase the interest of these Students in understanding the broader phases of the engineering field and in furthering their interests in the aims of SAE.

COFFEE SPEAKERS are planned to become a regular feature of the So. California Section dinners. These coffee talks will all concern developments in and about automotive racing events and will be presented by proponents of the racing industry.

JOHN A. C. WARNER, SAE secretary and general manager, spoke briefly at the October 17 meeting about the aims and achievements of SAE. He pointed out that standardization is the basis of mass production, while showing the extent to which SAE has gone to produce those standards over the years.

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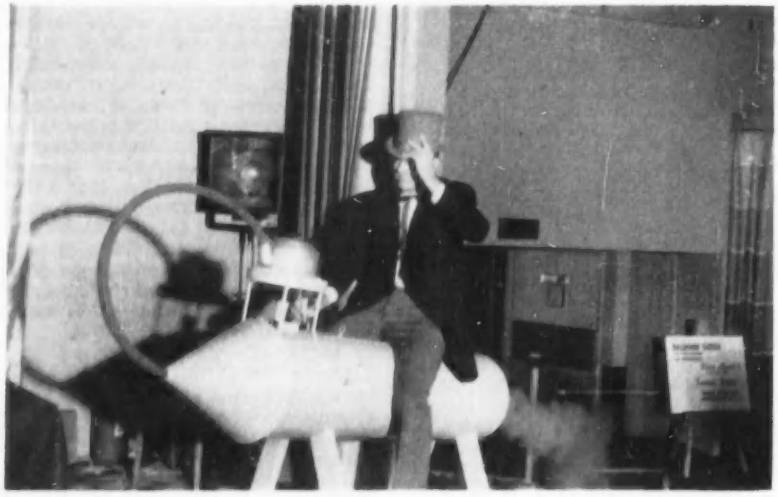


SAN DIEGO

W. F. Bunsen, Field Editor

SAE On TV Via San Diego Section

San Diego Section, under the direction of F. Herbert Sharp, has put SAE on television. Here's how we went about it:

Herb Sharp, chairman of the Friday, Oct. 14 evening session of the SAE Golden Anniversary Aeronautic Meeting, wanted to make his session something special and different. He was mulling over possibilities for his evening session program on the train between Los Angeles and Detroit last January. From somewhere, between the clicks of the rails, came to his mind: "Why not a TV show?" He broached the question to the Program Committee when he got into Detroit. They liked the idea, so he asked that San Diego Section be allowed to work up a plan.

With permission in hand, he immediately went to work with Convair's Public Relations Department, particularly R. G. Sharp, chairman of San Diego Section, and H. R. Dentz. Together they worked up a proposed script and layout for the eyes of the sponsor and producer.

The next step was to travel over to Los Angeles, pick up Ed Rentz, SAE Western Branch Manager, and arrange a get-together with the Richfield Oil people who sponsor the program "Success Story" Friday evenings on Station

(Cont'd)

A TV show comes into being:

1. Transportation in Cave-Man days becomes a prop for the Oct. 14 evening session TV show at the 1955 SAE Aeronautic Meeting in Los Angeles. Convair art department provides a dinosaur.

2. **San Diego Section Chairman R. G. Sharp** rides an 1825 cartoonist's idea of a rocket during the show.

3. Station KTTV camera crew takes in a chart displaying the tremendous increase in travel speeds brought about by aircraft development.

KTTV, Channel 11.

Richfield liked the idea.

Jack and Herb then made an appointment with Eric Strutt, the man who produces this show for KTTV. Strutt was much impressed with the script and layout. And, even though it meant departing from the general format of the show; he thought the occasion was important enough for them to take it on.

TV Committee Appointed

In the meantime, Herb appointed a TV Program Committee, including Section Chairman R. G. Sharp, F. E. McCreery of Rohr Aircraft, W. C. Heath of Solar Aircraft, E. F. Mellinger of Ryan Aeronautical, and H. R. Dentz of Convair.

This committee went ahead with plans based on the assumption that the show would follow the general lines of the proposed script. On Sept. 13 it met with Strutt to line up necessary props. Various aircraft companies in San Diego had agreed to provide the props needed. Companies in Los Angeles had been contacted for model airplanes. Wanted were 10 or 15 models to show the progress in aircraft design from the Wright Brothers' plane right on up.

The program became a unique production. Hundreds of people in plants all over the country spent hundreds of manhours preparing and shipping the huge props. Setting up the stage became a masterpiece of organization and cooperation.

Thoughts Turn to Tickets

As plans progressed, tickets and announcements had to be thought about. It was suggested that exhibitors be given tickets to distribute to promote a large audience, necessary for a successful telecast. This idea led to the suggestion that all exhibitors be asked to close down their rooms by 6:00 p.m. the night of the show. Bill Heath was assigned to contacting these men.

An announcement of the TV show was prepared by the Convair art department. It was printed up on 8½ × 5 paper to be passed out to each man as he registered and to be mailed to key members in the area.

Things ran smoothly. Except for a few timing difficulties on the day of the show, no real problems arose. All the cooperation that the committee received, from companies all over the country, from San Diego Section members, and from SAE headquarters, made failure a virtual impossibility. In fact the great success of the show was no surprise.

As the program was telecast, it was filmed via kinescope. The film is being made available for Section showings now.

R. G. SHARP (left), chairman of the SAE San Diego Section, welcomed **J. B. JOHNSON**, chairman of the SAE Aeronautical Materials Specifications Division, to San Diego. Johnson and his AMS Division met in San Diego for one week in October.

In his short address of welcome to the group, Sharp remarked that the Section is doubly appreciative that San Diego was selected as the site for the AMS meeting. He said that many of the Section members, associated with the aircraft industry in and around San Diego, use AMS and understand the contribution these specifications have made to the entire industry.

MILWAUKEE

J. W. Mohr, Field Editor

Production Men Hail Milwaukee Forum Series

Production forums have gone over in a big way in Milwaukee. N. P. Mollinger of the Ladish Co., chairman of the Section Production Forum Committee, is now making plans for a series of three forums to be held in the spring of 1956.

This campaign stems back to the original national Tractor Production Forum of 1951, held in Milwaukee. The achievements of this first affair inspired the Tractor and Farm Machinery Activity Committee to make it an annual event. The 1953 forum in all its success was chairmanned by Norm Mollinger. Now he is taking up the ball for the the Milwaukee Section itself.

The Governing Board of the Milwaukee Section feels that a service can be rendered to production men in the area, through the medium of production forums. The community has many active societies for technical people, but no organization, as such, to aid production men in an interchange of ideas for the mutual solution of problems. The Section's objective is basically to be of service. Achieving this for production men would open a whole new area of potential membership.

What group, other than the mass producing industries served by the SAE, would have more production problems? By the same token, what group is most able to solve these problems?

The Milwaukee Section answered these questions by sponsoring a trial production forum last April. The purpose of the forum was expressed by the title "Producing the Design." It was aimed at the joint problems of the designer and production-man. The panel was composed of experts in their fields, and was moderated by J. E. Schoen, professor of Mechanical Engineering, Marquette University. The panel members were:

H. L. Sanders—Production Purchasing, Ford Aircraft Engine Division

E. L. Breese—Planning Manager, Caterpillar Tractor Co.

R. Keller—Welding Research, A. O. Smith Corp.

A. Spelich—Quality Control superintendent, Waukesha Motor Co.

George Kopp—factory superintendent, Heil Co.

George Mork—development engineer, Bucyrus-Erie Co.

The informal atmosphere essential to a successful forum was encouraged by having the panel and audience become acquainted at a dinner preceding the discussion. Sixty percent of the group attending this successful trial forum were not members of the SAE, but are now active potential members.

NOMAN MOLLINGER (left) and **CHARLES HAGEN**, both of Ladish Co., planning the 1956 Production Forum Series.

The success of this undertaking has prompted the Milwaukee Section to expand their plans for production meetings in 1956.

Mollinger is now making plans for a series of three forums to be held in the spring of 1956. Mollinger's committee consists at present of Arthur Flamme, Taylor Dynamometer Co., and Charles Hagen, Ladish Co. The forum series being planned will employ techniques similar to those used for the national production meetings. Specific prob-

lems will be discussed in each meeting, however, by means of a case study, which will be presented by an expert in the particular field.

CERTIFICATES for 25- and 35-year membership will be presented as a highlight of the Nov. 4 meeting of the Section.

CHICAGO

P. P. Polko, Field Editor

Inspired Support Given Student Activity

A steady increase in student activity has been inspired in the Chicago Section. While the Student Activity Committee has coordinated this effort, the end results have been possible only because the Section members have been interested and have wholeheartedly supported this endeavor. Some of the reasons for increased interest are as follows:

An annual Student-Member dinner meeting is held featuring a program designed to appeal to both Students and members. This meeting, actively supported by the Section Governing Board, is held in the spring of each year on the campus of Illinois Institute of Technology. It features three students, each of whom has won a local paper competition at his respective school. These three winners each gives a ten minute paper at the Annual Student Meeting. The Grand Winner is awarded a trophy at the following regular Section dinner meeting.

In addition to the student papers, a distinguished guest speaker is also featured. We have been extremely fortunate in attracting guests such as our 1955 SAE President, Dr. C. G. A. Rosen; the late Wilbur Shaw; Dr. John Rettaliata of Illinois Institute of Technology; Joseph R. Gillette of Lincoln-Mercury; Harold L. Welch of Chrysler Corp.; and Walter Parks, editor of "Hot Rod Magazine."

The faculty advisors stimulate interest in the SAE in their Students, thus making possible active Student Branches and Clubs. The Governing Board demonstrates its appreciation for the important role played by these faculty advisors on their respective campuses by inviting them to be guests each year at the Speaker's table at a regular dinner meeting. Present faculty advisors are:

Leland W. Sims of Aeronautical University

Dr. Edward F. Obert of Northwestern University

Dr. Martin A. Elliott of Illinois Institute of Technology

It is recognized that a group of active

Section

ALBERTA

December 16 . . . Harris Sky Room

ATLANTA

January 9 . . . **Floyd A. Wyczalek**, Automotive Engines Dept., Research Laboratories Division, General Motors Corp., Detroit.—"Mechanical Octanes for Higher Efficiency." Dinner 7:00 p.m. Meeting 8:15 p.m.

BUFFALO

December 13 . . . **Dr. T. F. Hart**, Linde Air Products, Buffalo, N. Y.—"Synthetic Jewels." Hotel Sheraton. Dinner 7:00 p.m. Meeting 8:00 p.m. Special Features: Ladies Night—Christmas Meeting. Also included—Automotive Fabric Display by G. M. C. Styling Section.

CANADIAN

December 21 . . . Christmas Party—Bob Combs' Night. Royal York Hotel. Dinner 7:00 p.m.

CENTRAL ILLINOIS

December 19 . . . **N. Olson**, Aluminum Co. of America, Pittsburgh, Pa.—"Impact Extrusions of Aluminum." Pere Marquette Hotel. Dinner 6:30 p.m. Meeting 7:45 p.m.

CHICAGO

December 13 . . . **Dr. Maurice J. Day**, director, research development, Crucible Steel Co., Pittsburgh, Pa.—"High Performance Alloys." Hotel Knickerbocker. Dinner 6:45 p.m. Meeting 8:00 p.m. Special Features: Social Half-Hour—6:15 to 6:45 p.m. Sponsored by Crucible Steel Co.

CLEVELAND

December 12 . . . **R. C. Williams**, Euclid Div., General Motors Corp.—"Twin Power for Easy Mobility," **H. C. Kirtland**, Allison Div., General Motors Corp.—"Torquematic Drive—Its Part in Easy Mobility," **C. M. Jordan**, Styling Section, General Motors Corp.—"Twin Crawler Takes Shape." Tudor Arms Hotel. Dinner 6:30 p.m. Meeting 7:45 p.m.

INDIANA

December 15 . . . **Joseph Geschelin**, Detroit editor, Automotive Industries, Detroit.—"Outstanding Features of the 1956 Automobiles." Marott Hotel, Indianapolis. Dinner 7:00 p.m. Meeting 8:00 p.m. Special Features: Social Half-Hour 6:30 p.m.

INDIANA SECTION—
Fort Wayne Division

December 19 . . . **Joseph Geschelin**, Detroit editor, Chilton Co.—"The 1956 Automobiles." Dinner 7:00 p.m. Meeting 8:00 p.m.

METROPOLITAN

December 14 . . . **Herbert R. Otto, Jr.**, chief engineer, and **John C. Cox**, supervising engineer, Purolator Products, Inc.—"Dirtproofing Engines." The Engineering Societies Bldg., 29 West 39th St., New York. Meeting 7:45 p.m.

Meetings

METROPOLITAN

January 5 . . . **D. F. Gardner,** Current Controls Corp., Chicago. —"Weighing Vehicles Static and in Motion by Electronic Scales." The Brass Rail Restaurant, Fifth Avenue & 43rd Street. Cocktail Hour 5:30 p.m. Dinner 6:30 p.m. Meeting 7:45 p.m.

NEW ENGLAND

January 10 . . . Aeronautics Activity

NORTHWEST

January 6 . . . **Dr. Ulric B. Bray,** president, Bray Chemical Co., Los Angeles, Calif. Stewart Hotel, Seattle. Dinner 7:00 p.m. Meeting 7:45 p.m.

PHILADELPHIA

December 14 . . . **Robert Cass,** assistant to president, White Motor Co., Cleveland.—"Trends in Engines and Transmissions for Trucks." The Engineers Club. Dinner 6:30 p.m. Meeting 7:45 p.m.

January 4 . . **Grover Loening,** aircraft consultant—"Economics of Large Aircraft" (covering the field of airborne aircraft carriers, large cargo planes and large water based planes). Annual Joint Meeting with IAS. International Area of the Philadelphia International Airport. Dinner 7:00 p.m. Meeting 8:00 p.m.

SAN DIEGO

January 3

SOUTHERN CALIFORNIA

January 16 . . . **Major Thomas P. Savage,** director of the B-52 Operational Evaluation Section at Castle Air Force Base, Merced, Calif.—" 'De-Bugging' the B-52." Aircraft Dinner Meeting. Rodger Young Auditorium, Los Angeles, Calif. Dinner 6:30 p.m. Meeting 8:00 p.m.

ST. LOUIS

December . . . Annual Ladies Night Meeting. Program will include Dinner and probably a Theatre Party.

TEXAS

January 20 . . . **Bill Gibson,** sales mgr., Twin Disc Clutch Co., Amon Carter Field.

TEXAS GULF COAST

January 13 . . . Truck & Bus Activity Meeting.

TWIN CITY

January 11 . . . Speaker and Movie or Slides on Engine Topic.

WESTERN MICHIGAN

December 13 . . . **Earl C. Ginn,** executive vice-president, Continental Motors Corp., Muskegon, Mich.—"Meeting Present Day Power Requirements with a V-8 Diesel." Doo Drop Inn, Muskegon. Dinner 7:00 p.m. Meeting 8:00 p.m.

Student officers are necessary if the Student Branches are to be full of life. To stimulate the chairmen of the Student Branches and Clubs, an invitation is extended to each of them to be the guest, once each year, at the Speaker's table at a regular dinner meeting.

Each year your Student Activity Committee appeals for out-of-date SAE Handbooks and each year the Chicago Section responds very well, indeed. These Handbooks are then distributed to SAE Enrolled Students on each of the three campuses.

PITTSBURGH

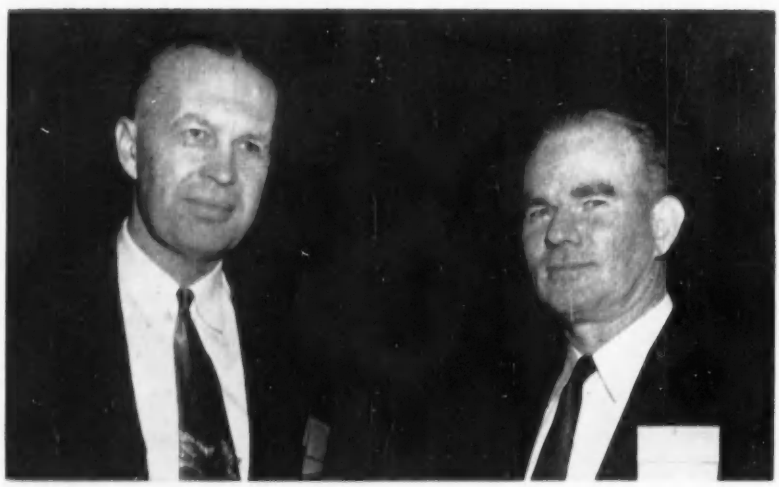
W. C. Weltman, Jr., Field Editor

MURRAY FAHNESTOCK (left) long an active member of Pittsburgh Section and editor of Ford Field Magazine, was honored at the Oct. 25 meeting. He was presented the SAE 35-year Membership Certificate by Section Chairman H. O. Creazzi. Fahnestock was chairman of the Section in 1933–1934.

STEPHEN L. TOMASIC, one of Pittsburgh Section's "faithful," received a page write-up with pictures in the October 23 issue of the Pittsburgh Press. Besides being the owner of an auto repairing business in Smithton, Pa., this man is "paid to live like a bum." Like Gabby Hayes, Steve created an acting job for himself by

From Section Cameras

throwing away his razor. He directs and produces pageants and parades, often using himself as the star performer since his own beard is the bushiest of all.



Central Illinois

Harlan Banister, Field Editor

Student-Section Activities Spark Widespread Enthusiasm

Joint activities have boosted interest in Student Branches at Central Illinois Section. Exposing Section members to the enthusiasm of the Students has served to put Student activities at the top of the list of Section Governing Board activities.

At the September Section meeting and dinner, three members from each Student Branch attended as guests of the Section. This has met with full approval from both the Students and the Section members. So, a full quota has been promised for each future dinner meeting.

As in many other Sections, one Central Illinois meeting each year is devoted to the Student Branches. These Student-Section meetings in the past

CONTINUED ON PAGE 94

1. **N. W. Carnell,** director of education, Holley Carburetor Co., speaks on "1956 Carburetion Developments." He was guest of the Atlanta Section at the October 10 meeting.

2. **Louis L. Otto** (left), Mid-Michigan Section chairman, presents **William T. Bean, Jr.,** consulting engineer. Bean was speaker for the Section October 10 meeting on How Experimental Stress Analysis Aids the Designer.

3. Caught in discussion at the Pittsburgh Section October 25 meeting are **Henry J. Grance, Jr.,** Gulf Oil Corp.; **A. D. McDuffie,** Research Laboratories Division, GMC; **Harry O. Creazzi,** Section chairman; and **Court L. Wolfe,** Mellon Institute of Industrial Research.

1956 SAE Annual Meeting And Engineering Display

1. Over **50 technical papers** in 25 sessions

2. Sessions sponsored by each of the **12 SAE Activities**

3. Feature events:

   Luncheon technical session—Tuesday, Jan. 10
   . . . a dramatization of the problems automation is bringing to top management, design engineers, and production men . . .

   Presidential address—Tuesday evening, Jan. 10
   Annual business session announcing election of 1956 officers, presentation of life memberships, presentation of annual report

   Horning Memorial Award presentation—Thursday, Jan. 12

4. **1956 Annual Meeting Dinner**—Detroit Masonic Temple, Jan. 11

5. **1956 Annual Engineering Display**—The Sheraton-Cadillac Hotel, Jan. 9-13

Detroit, Mich.

Jan. 9-13, 1956

The Sheraton-Cadillac Hotel

Hotel Statler Detroit Masonic Temple

COMMEMORATIVE SCROLL IS ACCEPTED on behalf of SAE by **Robert Cass** (right), a past president of the Society, from **Col. W. F. Rockwell**, president of Automobile Old Timers as

SAE Receives Citation From Automobile Old Timers

THE 50th anniversary of the founding of SAE was commemorated by a citation presented to the Society by Automobile Old Timers in New York, Oct. 28, at AOT's 16th anniversary dinner. SAE past president **Robert Cass** accepted the scroll (reproduced on the following page) on behalf of the Society and president **C. G. A. Rosen** who was unable to be there.

SAE members took a prominent part in the evening's activities. **C. F. Kettering**, 1918 SAE president was guest of honor and principal speaker.

Toastmaster and chairman of the dinner committee was **P. G. Hoffman**, chairman of the board of Studebaker-Packard Corp. Serving with him on the dinner committee were **Alfred Reeves**, advisory vice-president of the Automobile Manufacturers Association; **G. A. Martin**, president of Town & Country Motors, Inc., Greenwich, Conn.; and **H. A. Clark, Jr.**, owner of the Long Island Automobile Museum, Southampton, Long Island, N. Y.

Colonel W. F. Rockwell, president of the Automobile Old Timers and chairman of the board, Rockwell Spring & Axle Co., presented the scrolls.

OTHER DISTINGUISHED SERVICE CITATIONS were awarded to SAE members **Pyke Johnson**, former president of the Automotive Safety Foundation, Inc., (left), **L. L. Colbert**, president of Chrysler Corp. (center), and **F. C. Crawford**, chairman of the board of Thompson Products, Inc. (right). C. F. Kettering's address was broadcast over the American Broadcasting Co.

To the

Society of Automotive Engineers

Automobile Old Timers

Extends Greetings

to mark the Society's Golden Anniversary, and to signalize fifty fruitful years of distinguished service of its officers and members whose voluntary collaboration, toward advancement of the arts, sciences and practices of automotive engineering, has yielded practical benefits of inestimable value to mankind.

Founded upon the doctrine of attainment through cooperation, the Society's first half-century has amply demonstrated the solid substance of friendly creativity, notably in the realms of ground vehicle and aircraft engineering.

With proven certainty that sharing brings greatest satisfaction to men of good will and common purpose, the Society can have faith in its power to rise to spectacular new heights of achievement.

Automobile Old Timers offers hearty felicitations, and every good wish to the Society of Automotive Engineers for a brilliant future.

Given at its 16th Annual Meeting in the City of New York, October 28, 1955.

Honorary President

President

SAE Technical Services Aid Railroad Diesel Engineers

RAILROAD engineers right now are extracting a wealth of practical technical information from the Society on maintenance and operation of diesel locomotives. They see even broader opportunities for more of same ahead, for themselves and scores of their colleagues not now participating in SAE.

These are the observations of 17 railroad men who met informally with SAE President Rosen in St. Louis on Nov. 3.

The 11 SAE members and 6 nonmembers in this railroad group advised that the values to them from participation in the Society were manifold . . . from attending meetings, presenting papers, serving on committees, and using SAE literature.

President Rosen pointed out that SAE brings to its railroad members (as well as its other members) positive values from cross-fertilization of ideas. Men from related areas—such as fuels, lubricants, diesel engines, and vehicle transportation and maintenance—bring to the railroad man a fresh approach and new ideas that throw light on his own problems. The informal ties between diesel design engineers and the railroad men set up a direct communication bridge between builder and user.

At present SAE has members from 27 major railroads, advised President Rosen. The group indicated that there are scores of railroad men who could benefit from Society membership and participation.

This informal session concluded with the railroad diesel engineers agreeing that:

1. They want to take greater advantage of extracting technical content from the Society and will look for new ways of doing this.
2. They want to extend the opportunity of receiving SAE benefits to their railroad colleagues not now members of the Society.

During the SAE National Diesel Meeting in St. Louis last month, SAE President Rosen met with railroad diesel engineers to discuss SAE values available to diesel railroad men. Those present are shown in the photos above.

In the photo at left are, left to right: L. S. Crane, Southern Railway System; T. M. Robie, Fairbanks, Morse and Co.; D. S. Neuhart, Union Pacific Railroad; Gerthal French, Union Pacific Railroad; Clay Lewis, Jr., Missouri-Kansas-Texas Railroad; Wayne Lasky, Gulf, Mobile, and Ohio Railroad; SAE President Rosen; M. A. Pinney, Pennsylvania Railroad; F. Fahland, Union Pacific Railroad; R. W. Seniff, Baltimore & Ohio Railroad; R. A. Bardwell, Chicago and Eastern Illinois Railroad; and F. A. Robbins, SAE Vice President for Diesel, Koppers Co.

In the photo at right are, left to right: H. M. Hoffmeister, Missouri Pacific Lines; W. W. Matzke, Chicago and Northwestern Railway; A. E. Rice, Denver and Rio Grande Western Railway; A. L. Wright, New York Central System; E. C. Harris, Missouri Pacific Railroad; and H. W. Van Hovenberg, St. Louis Southwestern Railway.

1956 SAE National Meetings . . .

January 9-13
Annual Meeting
The Sheraton-Cadillac Hotel
and Hotel Statler, Detroit

March 6-8
Passenger Car, Body,
and Materials Meeting
Hotel Statler
Detroit

March 19-21
National Production Meeting
and Forum
Hotel Statler, Cleveland

April 9-12
Aeronautic Meeting,
Aeronautic Production Forum,
and Aircraft Engineering Display
Hotel Statler, New York

June 3-8
Summer Meeting
Chalfonte-Haddon Hall
Atlantic City, N. J.

August 6-8
West Coast Meeting
Mark Hopkins Hotel,
San Francisco

September 10-13
Tractor Meeting and
Production Forum
Hotel Schroeder, Milwaukee

October 2-6
Aeronautic Meeting, Aircraft
Production Forum, and Aircraft
Engineering Display
Hotel Statler, Los Angeles

November 1-2
Diesel Engine
The Drake, Chicago

TECHNICAL COMMITTEE *Progress*

Drafting Manual Under Revision

COMMITTEE S-1 has recently completed seven revisions and additions to the SAE Aeronautical Drafting Manual. Titles of the seven are Airframe Riveting, Symbolized Notes for Geometrical Surface Control, Symbols for Electrical Insulation, Detail and Assembly Drawings, Jewel Bearings, Lockwiring, and Simplification of Compression Spring Drawings.

Committee S-1 is the Aeronautical Drafting Manual Committee of the Special Aircraft Projects Division of the SAE Aeronautics Committee. P. G. Belitsos of General Electric is chairman of S-1.

Cabin Safety Provisions Under Study by New Group

SAE has formed a new group, Committee S-9 to consider cabin safety provisions at the request of the Air Transport Association. The Committee has decided "to confine itself to items and components of the aircraft which the occupants thereof may have to operate or use in an emergency."

First task the committee plans to tackle is to formulate recommendations on main cabin doors (openings used for normal loading), emergency exits, other exterior openings, external opening mechanisms, and placarding of location and method of operation of controls.

Later on, the Committee hopes to consider emergency lighting, emergency flotation equipment, and the stowage and placarding of escape devices, among other subjects.

Committee S-9 will function under the Special Aircraft Projects Division of the SAE Aeronautics Committee. Serving on the Committee are S. L. Higginbottom of Trans World Airlines, chairman; A. M. Salmon of United Airlines, vice-chairman; A. H. Hasbrook of Cornell University's Aviation Crash Injury Research Center, secretary; A. W. Dallas of the Air Transport Association of America; F. E. Davis of Eastern Air Lines; D. Enfield of Lockheed; O. T. Fleig of American Airlines; M. N. Gough of NACA; J. A. Graves of Douglas; J. C. Hoover of Convair; B. G. King of CAA; O. E. Kirchner, Sr. of Boeing; W. E. Koneczny of CAB; and Jack Vitol of CAA.

Next meeting of the Committee is scheduled to be held in conjunction with the SAE Annual Meeting in January in Detroit.

Extensive Report on Fretting Prepared by Hirsch, Boswell, and Palmer

FRETTING is a form of wear resulting from oscillatory surface slip at such low amplitudes that a lubricant film of finite thickness cannot be maintained between the surfaces.

This is the explanation appearing in a proposed draft of SAE Aeronautical Information Report No. 47 on Fretting. It was prepared by Harold Hirsch, C. C. Boswell, and J. L. Palmer, all of Hughes Tool Co., Aircraft Division.

The threesome, with Hirsch as chairman, is a subcommittee of SAE Committee S-2, Helicopters.

First part of their proposed AIR covers history, occurrence, theories, and dangers of fretting. A subsequent portion deals with effects of lubrication, surface finish, surface hardness, the oxide formed by the metal, surface preparation, temperature and humidity, and load. A section on prevention and mitigation of fretting precedes a list of 79 references and abstracts from them.

When the report has been approved by Committee S-2; its parent body, the SAE Aeronautics Committee; and the SAE Technical Board, the AIR will be reproduced and made available through SAE headquarters.

Sections

Continued from page 88

have included debates between the Bradley Student Branch and the University of Illinois Student Branch members. Or, sometimes the program has included a panel discussion between students of both schools and representatives from industry.

This year the two best papers received in the Student Branch Technical Paper competition from each Branch will be presented. Cash awards are planned.

Section members working with the Branches are recent graduates of the two schools. Thus they are particularly well qualified to give counsel to the Governing Board on what the Section can do for the students to maintain active Student member participation in SAE.

R. D. Henderson, chairman of Student activities, has two able assistants in Charles Hudson, recent graduate of the University of Illinois; and Robert Grover, recent graduate of Bradley University.

Having gotten the Branches off to an early active start, these men predict the most successful year yet.

PLANS for the 1956 Earthmoving Industry Conference are on the way to completion. Both the Keynote Speaker and the Dinner Speaker have been invited. The Conference will be held April 3–4, 1956.

KANSAS CITY

H. H. Hart, Field Editor

Rogers Holds the Reins In New Members Campaign

John Drake Rogers, Kansas City Section Membership chairman, is leading his Section into an all-out crusade for new SAE'ers. He is conducting his own personal campaign to set the perfect example.

Letters are going out from Rogers to all well-qualified prospects. These letters are then being followed up with a personal visit to each of the men.

Meeting notices have been posted on bulletin boards in all major companies of the Kansas City area, including the Kansas City plant of Westinghouse Electric Corp.

(A story on the SAE membership growth in this Westinghouse Kansas City plant will appear in a forthcoming issue of SAE Journal.)

Section members in each of the major companies have been delegated special duties in order to distribute better the efforts of the Membership Committee.

DETROIT

W. F. Sherman, Field Editor

Long Range Planning Pries Out What's Wanted

"Is the SAE in Detroit doing the best job it can for the members?"

"Can it be done better?"

"How should the Section tackle the problems that come with growth, new interests, and wider scope of activities?"

Questions like these arise in the mind of every SAE officer and in every section, but Whitney Collins of Continental Aviation & Engineering Co., posed these questions in 1954 to fellow-members of the Detroit Section Governing

Board.

To the Governing Board it seemed reasonable to believe that answers should be sought, and new information on these and similar questions put to work for the benefit of members.

On November 2, 1954, a recommendation of the Executive Committee for the establishment of a Long Range Planning Committee was approved by vote of the Detroit Section Governing Board.

This was the beginning of an investigation and study on the part of C. C. Dybvig of Dana Corp. (as chairman), Earl F. Riopelle, Lunkenheimer Co., and Whit Collins. It resulted in creation of a standing committee consisting of Collins, as chairman; M. J. Kittler, vice-president, Holley Carburetor Co.; and William S. Coleman of General Motors Research Laboratories Division. The purpose of the committee is to conduct a careful and continuous study to provide information and advice to the Governing Board on policies to make possible the full realization of the chartered purposes of the SAE for each individual member.

Collins

Kittler

Coleman

The committee first set out to provide itself with some tools with which to work. In the words of 1954–55 Chairman Dybvig, it "wanted to find out the character and interest of the SAE membership, the trend of any changes in membership, and what the interests of the members are."

To determine something about the latter point, it decided to get data on meeting attendance in relation to:

1. subject matter of meetings
2. the distribution of membership with regard to industry
3. job category.

Among the aspects of meeting attendance to be analyzed is the basic question whether the meetings should be of broad general interest, or more specialized and technical in content. However, the committee will investigate other subjects such as the members' desire for dinner or non-dinner meetings, and social activities. It will seek to determine whether there are any new activities which should be represented in the Detroit Section, or others which should be dropped or combined for meeting purposes.

The committee is also going to take a look at what steps can be taken to create roles for younger members, to retain their interest and take advantage of their new ideas.

In view of the fact that the Section is outgrowing its present facilities at a rapid rate, it is even going to explore questions about possible future meeting places.

It is the consensus of the committee that its work could have a very beneficial effect on the future of the Detroit Section, and even on the Society generally. This group, not being deeply involved in day-to-day urgencies which confront the officers and Board, will take a more intensive look at the various problems confronting SAE.

It is also believed that the committee may bridge over the personnel changes

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Sections

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which occur from year to year in the administration of the Section's activities. This will help to maintain a continuity of policies and practices which are found useful in operating the Section's meetings.

Questionnaire Submitted

To carry out this program of obtaining more information, the committee prepared and submitted to the Board a proposed questionnaire. With modifications, this was approved and distributed on September 20, 1955, to nearly 4,500 members of the Detroit Section. The questionnaire was prepared by committee chairman Collins, but the covering letter was from Section Chairman K. R. Herman. It said:

"Like every healthy enterprise these days, your Detroit Section has been growing by leaps and bounds. In past years, your Governing Boards have kept pace remarkably well in providing an increasing number of lively, interesting meetings on timely topics. And the programs scheduled for 1955–1956 will top them all.

"But I am certain that we can do still better—with your help. We want to know more about you—your business activities, your technical interests, your meeting preferences, etc. To this end, we have enclosed the attached questionnaire. A few minutes of your time will provide information of inestimable value to future Governing Boards in planning the activities in coming years."

Phenomenal Response

Response has been phenomenal. Approximately 50 per cent of the members of the Section checked off their replies and flooded the Detroit SAE office with the returns.

Currently, the information from the questionnaires is being processed on IBM machines. It is expected to be submitted to the Governing Board, along with analysis by the Long Range Planning Committee, at an early date.

In view of the possible value of this kind of information to other sections, it is planned to publish subsequent developments in the SAE Journal.

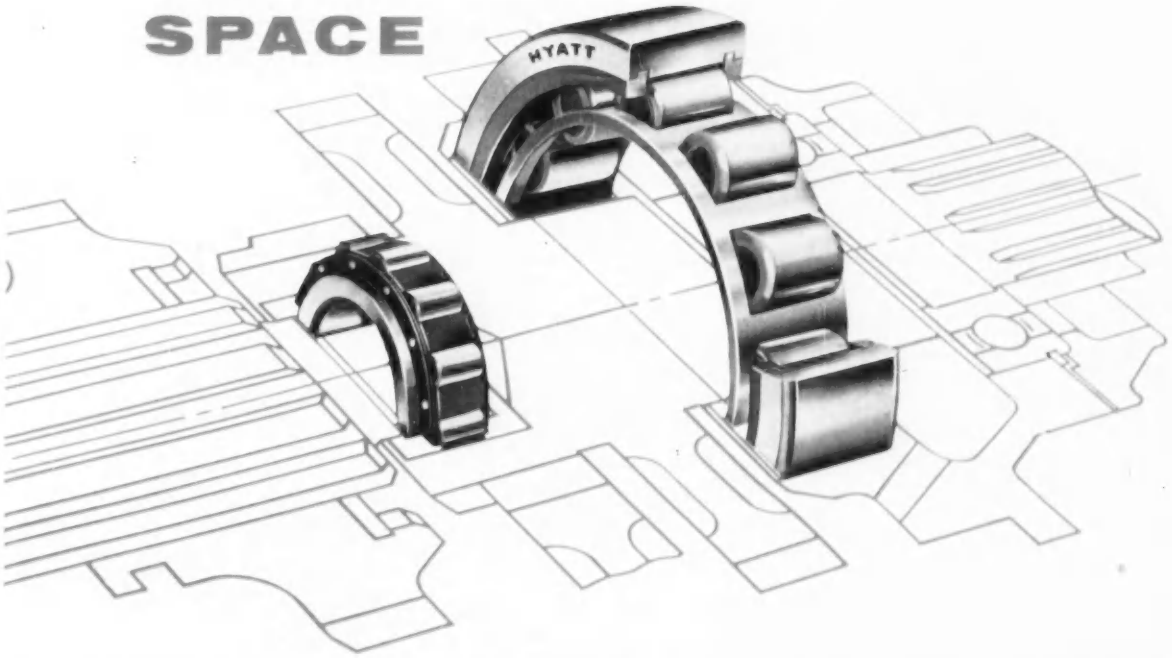
Hearty Applause Given Trial Three-Way Meeting

A three-way combination meeting was given an experimental check-out by the Detroit Section at its session on November 7 at the Rackham Educational Memorial Building. Observers pronounced it a marked success, with nearly 800 members participating in

CONTINUED ON PAGE 98

How Hy-Loads can help you

...SAVE SPACE



HY POTENUSE, the sage of the slide rule, SAYS:

your **COMPLETE LINE** of cylindrical roller bearings

Here's a tractor transmission where the designer's done a mighty fine job of cramming the whole works into a housing with dimensions tighter than McTavish's purse strings!

See how he did it? He used a HYATT BU-type Cylindrical Roller Bearing at the pilot position with the *outer race omitted*. Then on the input shaft he used a HYATT TS-type bearing with the *inner race omitted*. Gear-box size is held to a minimum with maximum bearing capacity! Hyatt makes 4 types of Hy-Loads with separable inner races and 2 types with separable outer races. And brother, they sure come in handy when you're cramped for space! If you haven't a HYATT General Catalog No. 150 handy, better send for yours right now. It'll help you find the answer to lots of pesky problems. Hyatt Bearings Division, General Motors Corporation, Harrison, New Jersey.

HYATT

ROLLER BEARINGS

STRAIGHT ◯ BARREL ◯ TAPER ◯

Sections

Continued from page 96

the various sessions.

Diversity of interests of the many engineering specialists in the Detroit area, plus the desire of many members for more intensely technical sessions was responsible for the decision of the Section Governing Board to attempt this type of meeting. A joint dinner was held, attended by 652 members, and followed by three separate, individual sessions sponsored by the Production Activity, the Truck and Bus Activity, and the Engineering Materials Activity respectively.

Inasmuch as the Section normally plans only one major meeting a month during the fall, winter, and spring session, this experiment demonstrated that it was possible to provide technical material of interest to a large number of members by staging specialized sessions simultaneously.

THE JUNIOR GROUP of Detroit Section took a very interesting tour on October 18 through the Ford Dearborn Iron Foundry. Among the highlights of the tour were the fabricating of sand cores from the initial blowing of sand into core molds to the assembly of the baked cores into casting molds; the subsequent pouring of metal into assembled casting molds; and the final removing of the formed casting from the mold.

In touring the 27 acre foundry, where 2,800 tons of metal are poured per day, the members present were divided into small groups guided by experienced foundrymen, who helped to make the trip very interesting.

—Submitted by J. C. Streicher

FRED C. MATTHAEI, JR., Detroit Section Membership Committee chairman, announces that 10 additional members of the Section will cooperate with the company representatives as the Membership Committee.

CLEVELAND

W. B. Fiske, Field Editor

TWO STUDENT AWARDS have been given out by Cleveland Section. John E. Matsik and James T. Van Kuren each received a cash award and a membership card for an SAE Student Branch. The recipients were honored for their high quality school work, interest and success in outside activities, character recommendations, and the earnest desire to continue and complete their engineering education.

No. California

L. J. Abell, Field Editor

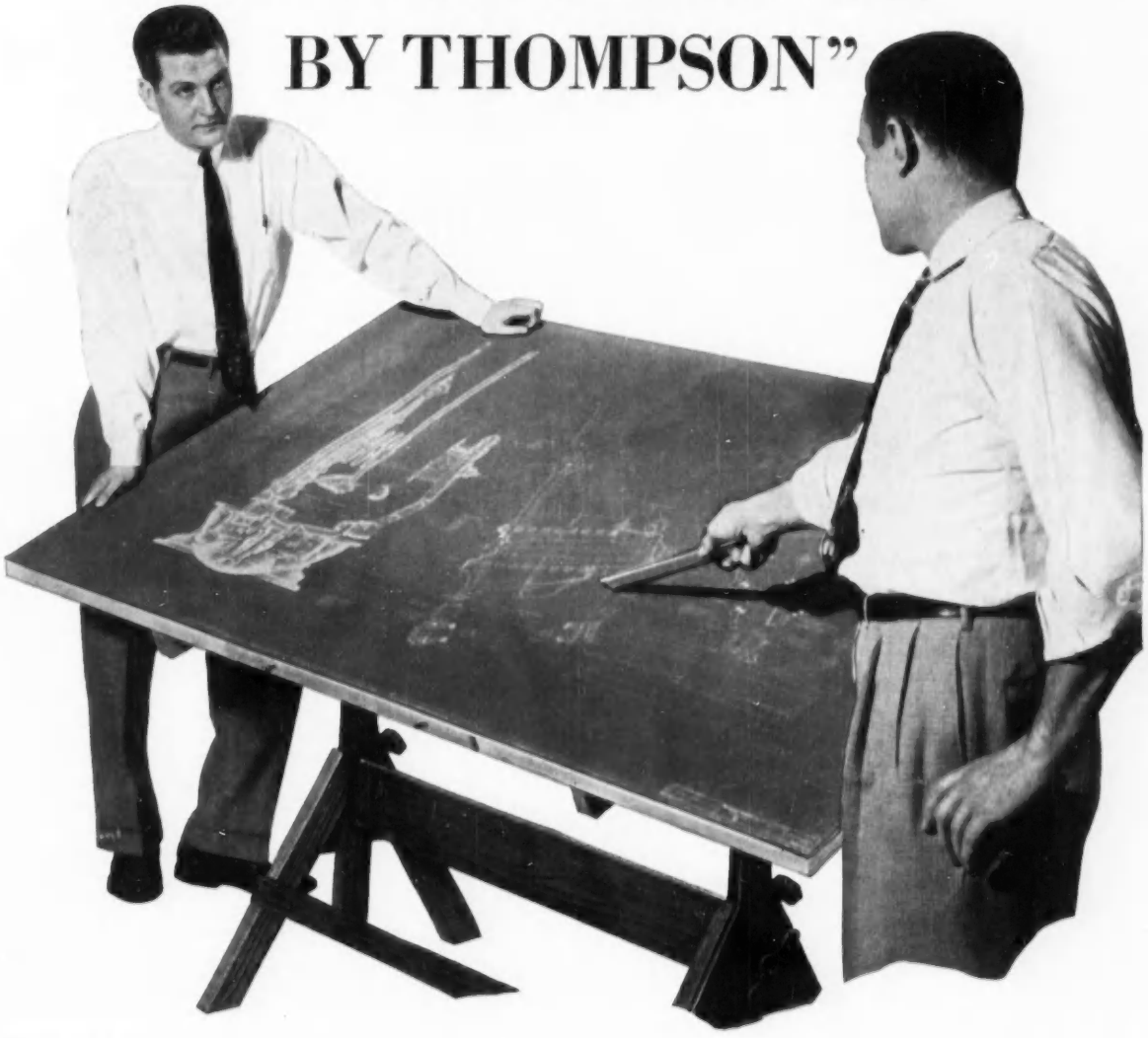
NO. CALIFORNIA SECTION greeted the speaker for the October meeting with a luncheon at San Francisco's Fisherman's Wharf. John W. Lane of Socony Mobil Oil Co. was the guest of honor. The Chef apparently knew he was coming. The menu included "Baked Halibut ala Lane."

SOUTH BAY DIVISION has appointed three program co-chairmen to make arrangements for the Division meetings. The Division feels that pro-

CONTINUED ON PAGE 100

"Let's be sure to specify

STEERING LINKAGE BY THOMPSON"



MORE and more automotive manufacturers today specify "Steering Linkage by Thompson" when designing and planning their cars, trucks, buses and tractors of tomorrow.

And for good reason—for they've learned that "You Can Count on Thompson" as a dependable source of supply. And they've learned, too, to count on Thompson for important developments in ball joint design, for steering linkage, as well as other applications. Thompson's steering linkage units are in yesterday's cars and today's cars. And they'll be in tomorrow's cars, too.

Typical of these developments is the revolutionary Thompson-engineered front suspension ball joints, the greatest advance in automotive front suspension in 20 years. For over 50 years Thompson has played an important role in the automotive world.

If you use steering linkage assemblies, specify "Steering Linkage by Thompson". For details on how Thompson's skilled steering engineers can help you with your steering linkage developments, write, wire or phone Thompson Products, Inc., Michigan Div., 7881 Conant Ave., Detroit 11, Michigan, WA 1-5010.

Thompson Products

MICHIGAN DIVISION

DETROIT · FRUITPORT · PORTLAND

Sections

Continued from page 98

gram planning is more than a one-man job. F. W. Fingerle, W. A. Casler, and C. F. Carey are doing an excellent job as the planning team.

STUDENT MEMBERS should receive more recognition and attention according to the South Bay Division Governing Board. To make this possible, the Student members are given large green tags to designate "special privilege and attention." These special "card taggings" have increased the student recognition and are considered to be helpful and enlightening to all parties concerned.

Mid-Continent

C. L. Cotton, Field Editor

A **ROSTER** of Section members has again been distributed by Mid-Continent. This listing is divided into three parts. The first contains the list of officers for 1955–1956, committee chairmen, and representatives. Part two is an alphabetical listing of all the Section members. Part three lists the members and their addresses alphabetically by cities.

CINCINNATI

H. E. Pitzer, Field Editor

Interest At A Peak In Student Competition

Edward Lohaus reports enthusiastically that interest is developing to a peak in the Section Student Technical Paper Competition. Lohaus is Cincinnati Section Vice-Chairman of Student Activities.

One Student anticipated the program again this year and completed his paper in the summer in his spare time.

The invitation to Student members to enter competition specifies that:

"The paper shall be pertinent to SAE activities in any one of the following groups or subdivisions thereof:

1. Aeronautics
2. Passenger Cars & Trucks

CONTINUED ON PAGE 102

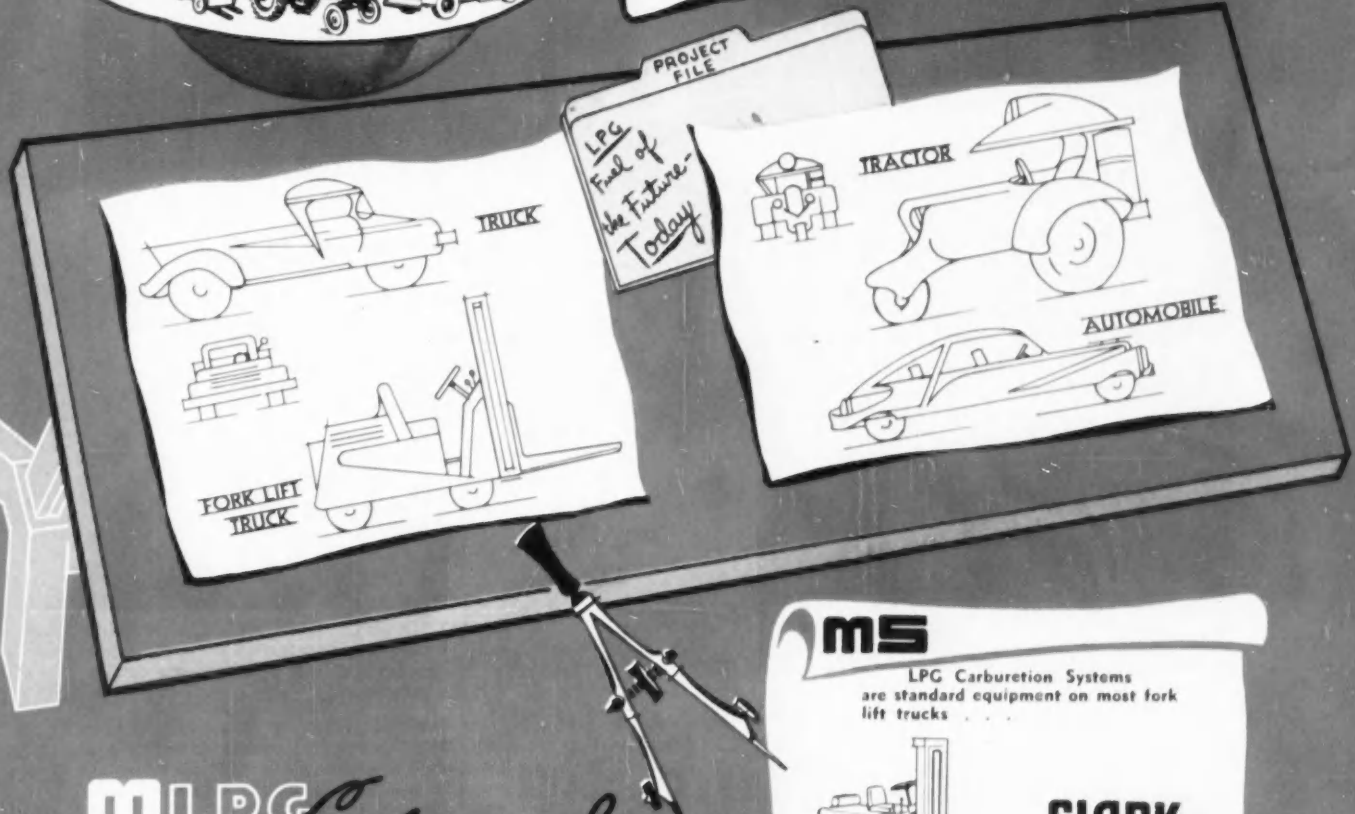
MARVEL-SCHEBLER'S

HALF CENTURY OF

CARBURETION "KNOW-HOW"

IS SOLVING LPG

ENGINEERING PROBLEMS TODAY!

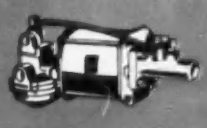


MS LPG Carburetion Systems

FOR TRACTORS, TRUCKS, PASSENGER CARS AND FORK-LIFT TRUCKS

For almost half a century, Marvel-Schebler engineers have been called upon to help solve your carburetion problems. Today, with more and more engines being designed exclusively for LPG operation, experienced Marvel-Schebler engineers are at your service. Complete LPG testing equipment, including accurate dynamometer reports are available to you. Whatever the application, Marvel-Schebler has the facilities to fit the need!

Gasoline Carburetors For Tractor, Aircraft and Industrial Engines



Power Brakes For Passenger Cars and Trucks

MS

LPG Carburetion Systems are standard equipment on most fork lift trucks . . .

CLARK

TOWMOTOR

HYSTER

MS MARVEL-SCHEBLER Products Division

BORG-WARNER CORPORATION • DECATUR, ILLINOIS

BW

For a completely equipped and expertly staffed research laboratory for power brake, LPG and gasoline carburetor development . . . plus trained engineering field men to assist you . . . call Marvel-Schebler!

Sections

Continued from page 100

3. Engine & Other Component Parts
4. Fuels & Lubricants
5. Construction & Industrial Equipment
6. Production Equipment, Tools & Methods.

"It shall be a technical paper presenting the writer's views on a specific project, operation, design, or problem."

Cash prizes will be awarded for the top three papers. The First Place paper will be presented at the Student-Section meeting in March. Awards will be made then by Fred W. Biederman, Cincinnati Section chairman.

The award board will consist of the Student Branch Faculty Adviser, the Cincinnati Section vice-chairman of Student Activities, and a member of the Section.

So. New England

S. L. Leavitt, Field Editor

TECHNICAL CHAIRMEN have been selected by the Section for all regular 1955–1956 Section meetings. A special meeting chairman will be appointed for the Section 20th Anniversary meeting to be held Jan. 31, 1956.

NAMES of new members and transfering members of the Section will appear on the backs of the monthly Section meeting notices from now on. This will enable members to lend a hand to the Reception Committee in welcoming these members to the Section.

AN ACTIVITY COMMITTEE has been formed by the Southern New England Section Governing Board. The committee will consist of six to ten members and will act as a steering committee for the promotion of activities in the Section.

Texas Gulf Coast

THE DECEMBER MEETING will feature presentation of 25- and 35-year Membership Certificates to Section members.

SOUTH TEXAS DIVISION's November 28 meeting featured the presentation of a certificate to Robert Best for 25 years of active membership in SAE. Best is manager of the Engine and Equipment Research Section, Engines, Fuels, and Lubricants Department, Southwest Research Institute. Throughout his 25 years of membership he has been very active. He was chairman of the Buffalo Section in 1950–1951. In the South Texas Division, Gulf Coast Section, he was Placement chairman in 1953–1954, Meetings chairman in 1954–1955, and is now serving as Membership chairman.

New England

George T. Brown, Field Editor

THE SECTION PUBLICITY CHAIRMAN plans to widen the scope of publicity of New England Section meetings and activities by getting greater coverage in local papers.

FEI Seeks Safer Farm Equipment

Based on paper by

MARTIN RONNING
Minneapolis-Moline Co

SAFER design and use of farm equipment has been one of the chief goals of the Farm Equipment Institute during the past years. Some of the projects in safety design undertaken are as follows:

1. A guard protecting the tractor operator from the power take-off shaft has been standardized. It was constructed so that it could not be easily removed from its proper position without tools or a cutting torch.

2. A remote-control hydraulic cylinder for operating the implement was developed and standardized. This relieves the operator from raising or lowering a combine or picker by hand, and reduces the chances of accidents.

3. A lighting system for farm machines on the highway after dark was standardized. Briefly, this consists of a large light showing red to the rear and amber to the front and set out to the left indicating the furthest projection of the equipment into the highway. At least two red reflectors on the rear of the machine are required, too. Of course, standard headlights must be provided.

4. A set of safety signs was standardized. They are attached to the hazardous areas on various farm machines. One sign, designed to last for the life of the machine, lists the following warnings:

a. Keep all shields in place.

b. Stop machine to adjust and oil.

c. When mechanism becomes clogged, disconnect power before cleaning.

d. Keep hands, feet, and clothing away from power-driven parts.

e. Keep off the implement unless seat or platform is provided.

f. Keep others off.

In farm machine design care must be taken not to adopt devices that will give the operator a false sense of security. For example, it's unwise to try to prevent the tractor from overturning by attaching a device that will cut off the ignition at a predetermined tilt angle. It's been proved that the flywheel of the engine will carry the tractor past the safety point after the ignition is cut off.

(Paper "Safer Design and Use of Farm Equipment" was presented at the SAE Golden Anniversary Tractor Meeting, Milwaukee Sept. 14, 1955. It is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Turbine Suspensions Have Big Job to Do

Based on paper by

JACK REBMAN
Lord Mfg. Co

ROTOR unbalance, gearing disturbances, gas flow turbulence, and propeller mass and aerodynamic unbalance, all represent sources of vibra-

tory energy making the turbine powerplant an exciter of considerable output. The fatiguing effects are felt by personnel, equipment, and structure.

The turbine itself, installed in the airframe, is subjected to many and severe loadings of steady state and repeated nature. And the situation is aggravated by thermal expansion and attaching point tolerance. Therefore, the flexible suspension holding the powerplant in the airframe must protect one from the other.

Temperature is one of the important dimensions in considering the fit of the mounting in the installation. Generally speaking, the further forward the mounting on the engine, the cooler the temperature of the engine attaching point. For existing engines the range would be from 150 through 900 F, and the cooler the better.

The normally recommended maximum temperature limit is 171 F for continuous operation of elastomeric mountings when a service life of 1000 hr is expected. Higher temperatures can be tolerated if a lower service life is accepted. One turbojet installation with synthetic mounting is operating at 250 F maximum continuous temperature under severe stress conditions.

Air cooling can reduce mounting operating temperatures. To make the most efficient use of available air, with minimum cost in weight, a system of integral air cooling is now in use. It consists simply in providing heat transfer passages and surfaces as integral parts of the mounting components.

Proper use of thermal insulation can bring temperature advantages without significant weight and space costs. It has been particularly useful at those mounting points having moderate temperature such as the forward gearbox attaching pad. A convenient form for application is sheet material interposed between the engine attaching pad and the mounting.

With available material and techniques, practical mounting installations can be made with engine temperatures as high as 550 F. For higher temperatures and simpler installations, there must be basic improvements in the ability of flexing sections to withstand high temperature environment, and the use of nonelastomerics must be considered.

(Paper "Flexible Suspensions for Turboprop and Turbojet Powerplants" was presented at SAE Golden Anniversary Aeronautic Meeting, Los Angeles, Oct. 14, 1955. It is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Synthetics Predominate In Upholstery Fabrics

Based on presentation by

ROBERT H. LANKFORD AND MARIANNE STRENGEL

Chatham Mfg. Co.

Reported by

E. B. ETCHELLS,

Chevrolet Motor Division, GMC

MANY automotive fabrics now use 80% synthetic fiber combined with 20% natural fiber. The result is more brilliance and luster and better wearing qualities.

But the synthetics are generally more difficult to handle, and they require modern machinery. They react differently to dyestuffs. They even

vary from piece to piece of the same material and design.

The balance of the fabric is usually wool, which adds softness. Sometimes there are metallics interspersed also to add highlights and richness.

(Presentations were made at SAE Detroit Section Summer Meeting, White Sulphur Springs, W. Va., Sept. 10, 1955.)

Temperature Governs Spark Plug Performance

Based on report by

J. R. SCHMITT
Standard Oil Co. of California

TO perform satisfactorily a spark plug must operate within the correct heat range. This range, or temperature zone, is controlled primarily by the design of the insulator core nose—that part extending into the combustion chamber. Long noses give the so-called hot type of spark plug; short noses give cold types. A spark plug operating below its proper heat range is too cold to burn off combustion deposits; hence fouling and misfiring occur. If it operates above its heat range, some part of the spark plug may become so hot that it ignites the fuel-air charge before ignition occurs. This pre-ignition causes tremendous and rapid increases in combustion chamber temperatures and pressures and can cause severe engine damage.

By attaching thermocouples at various points along the surface of the firing end of the insulator and on the center and ground electrodes, much information has been gained about spark plug temperatures during actual operation. If, for instance, the tip temperature falls below 600 F, deposits form which permit electrical shorting. These deposits are mostly carbonaceous. It has also been pretty well established that whenever insulator tip temperatures reach 1600 F pre-ignition occurs.

The heat range of the spark should be matched to the operating temperature of the engine. Generally speaking, the use of hotter-than-recommended heat ranges is advantageous in dense, stop-and-go, city driving conditions. The best heat range ap-

Serving on the Panel were . . .

Chairman:
M. E. Russell
The Ethyl Corp.

Secretary:
J. R. Schmitt
Standard Oil Co. of California

Panel Members:
J. A. Edgar
Shell Oil Co.
H. F. Galindo
California Research Corp.
W. E. Bettoney
E. I. duPont de Nemours & Co., Inc.
W. G. Nostrand
Winslow Engineering Co.
P. H. Hunter
Champion Spark Plug Co.

plication will be obtained when the insulator nose has a brown up to a chalky white appearance.

Proper installation of a spark plug is important although much neglected. The gasket transfers 75% of the heat. As a general rule, the spark plug should be given a three-quarter turn after it has been turned up to the gasket by hand.

(This article is based on the secretary's report of the Panel on Problems Encountered With High Powered Output Light Pick-up Trucks Used Mostly in Dense City Traffic Driving, held as part of the SAE Golden Anniversary West Coast Meeting, Portland, Ore., Aug. 16, 1955.)

Lab Functional Tests Throw Light on Greases

Based on paper by

T. G. ROEHNER

and

E. L. ARMSTRONG

Socony Mobil Laboratories

THREE types of functional testers are used by our laboratories in the attempt to predict performance properties of greases under actual service conditions. The first type is a chassis constant load tester. It employs a steel pin and oscillating bushing and has four test bearings employing loads up to 1500 lb per bearing. The unit is a modification of one designed by International Lubricants Co., reported by Hendricks and Smith in **The Institute Spokesman** in January 1951.

The second type is a chassis cushioned shock tester, designed for the purpose of giving a closer approximation of actual service conditions. It uses the same type of bearing specimens but the loading is so arranged that a constant 500 lb load is obtained with a calibrated spring and an additional 500 lb load is applied 50 times per minute as either a cushioned shock load or a direct hammer blow.

A vibrating front-end suspension tester is the third type in use. This unit employs either a Ford ball joint or Chevrolet spherical joint front-wheel suspension. The tire rides on a cam with appropriate "bumps" to simulate a cobblestone road. The joints are stressed in all three directions. At the present time, this unit is operated for several million cycles, then torn apart for inspection. The unit also can be used as a vibrating wheel-bearing tester.

When tests were run with the constant load tester to determine hours of life versus ASTM work penetrations

for a series of aluminum and a series of lithium soap greases, the stiffer grease gave the longer bearing life for the aluminum soap grease series, while the softer consistencies gave the longer protection for the series of lithium soap products. However, this does not mean that all aluminum and lithium base greases would behave in this manner. Rather it is illustrative of the type of data obtained from the tester.

One of the principal reasons for the decrease in bearing life with increase in consistency of the particular series of lithium-base grease tested, was the marked resistance of the stiffer compounds to structural breakdown under shearing action. In the oscillating type of plain bearing, the rate of renewal of lubricating film was reduced as the consistency of the grease was increased from the light to the heavy end of the series. (Paper "Common Denominators for Automotive Chassis Greases" was presented at SAE Golden Anniversary Summer Meeting, Atlantic City, June 15, 1955. It is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Rotators Prolong Tractor Valve Life

Based on paper by

J. A. WEBER

University of Illinois

TO determine the effect of rotation and alcohol-water injection on farm tractor valve life, 60 tractors, equally divided between two makes, were given a two-year test under owner operation. As a result of these tests the following conclusions were drawn:

1. The relatively small amount of injection of alcohol-water did not prolong valve life in tractors burning regular gasoline.

2. No valve failures occurred in tractors using white gasoline with alcohol-water injection.

3. The importance of injection for prolonging valve life is limited to enabling the use of white gasoline in tractors of higher compression ratio.

4. An alcohol-water injector must be completely closed off from its dusty farm environment and provided with a source of clean air.

5. Problems of storing a 50%-alcohol, 50%-water mixture included separation of inhibitor and rusting of storage drums. Commercial distribution should eliminate these problems.

6. Half of the tractors burning regular gasoline without rotators had an exhaust valve failure in less than two years of operation.

7. The differences between white and regular gasoline were the only factors of fuel type or quality tested which had a significant effect on valve life, there being no failures with white gasoline.

8. Tractors burning regular gasoline had excellent valve life with positive rotation. Tractors with rotators ran as long as 5 years (3120 hr) without valve failure.

9. Rotated valves had cleaner stems and smoother faces than valves in check tractors.

10. Useful life of positive type rotators was 2000 hr.

11. Maintenance of test tractors by owners and operators left much to be desired.

(Paper "Effects of Rotation and Alcohol-Water Injection on Farm Tractor Valve Life" was presented at SAE Golden Anniversary Tractor Meeting, Milwaukee, Sept. 15, 1955. It is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

New Members Qualified

These applicants qualified for admission to the Society between October 10, 1955 and November 10, 1955. Grades of membership are: (M) Member; (A) Associate; (J) Junior.

Atlanta Section

James L. Broom (M), R. Rex Burnett (A), Harold E. Kite (A).

Baltimore Section

Ward M. Carpenter (M), Donald H. Groft (M), Gerald E. Lutz (J), R. James Pfeiffer (A).

British Columbia Section

George T. Perry (M).

Buffalo Section

Ralph Park Maratta (M).

Canadian Section

Burton A. Avery (M), Hector L. Humphrey (A), Peter B. Mackenzie (J), Donald E. McLean (J).

Central Illinois Section

Donald M. Horning (M), Edward G. Orth (J).

Chicago Section

Hayri Adanali (J), Carl John Eichinger (J), Gerald H. Freier (J), Thomas M. Holland (J), Herbert C. Kroeplin (M), Waldemar C. Lindstrom (M), M. J. Marty, Jr. (M), Joseph P. Meli (M), Richard P. Molloy (J), John A. Rassenfoss (M), Walter E. Sargent (M), Otmar E. Teichmann (M), John E. Tudor (A), Leo G. Weaver (M).

Cincinnati Section

Arthur Philip Bray (J), David Cochran (M), Jack E. Koch (J), John C. Schneider (J).

Cleveland Section

Ellis J. Airola (M), William A. Compton (M), Mario A. Di Federico (M), George A. Kling (M), James H. Simler (J), Ray J. Stanish (J), Edwin C. Watson (M).

Colorado Group

Richard R. Riss, II (M), George P. Townsend, Jr. (M).

Dayton Section

Earl W. Reinsch (M).

Detroit Section

Charley E. Bengtsson (M), Samuel W. Blanton (M), John A. Bryant (J), Frank A. Cillette (M), Donald G. Davis (M), Frank Dickenbrock, Jr. (J), Alvin P. DuDeck (J), David H. Edwards (J), Norman W. Faustyn (M), Ernest C. Harris (M), Richard Eric Hinze (J),

New Members Qualified

continued

Gibson O. Hufstader (J), Milton W. Jumisco (M), Alfred W. Klomp (M), Leon P. Kocol (M), Carl F. Kop (M), Stephen T. Kusner (A), George W. Lawler (A), Louis M. Lutz (M), Edgar M. MacDonald (M), Alastair S. MacLennan (J), Henry A. Nickol (J), Hendryk R. Piecura (M), Louis F. Ponziani (J), Nick Popiel, Jr. (J), Michael E. Quinn (J), Marcel R. Raveschot (M), William A. Rosnyai (M), Robert W. Sanderson (M), Lowell C. Schneider (J), Louis W. Schultz (J), Thomas C. Schultz (M), Albert Sniderman (M), Jerzy Sztykiel (J), Thomas S. Taylor (J), Robert P. Thimot (J), Kelly W. Thurston (J), Clifford C. Voss (M), Leonard J. Zang (M), John F. Zerbey, III (M), Henry Zeuner (M).

Hawaii Section

R. H. Luke (M).

Indiana Section

Alfred G. Beier (J), Howard J. Jordan (J), Richard James Turner (M), Thomas J. Weir (M).

Kansas City Section

R. B. Speirs (M).

Metropolitan Section

Henry E. Buttelmann (J), Brian Persse Emerson (M), Martin Freedman (A), Lawson H. Frew (M), Howard B. Huntress (M), Donald L. Irwin (M), Francis L. LaQue (M), Theodore Malgeri (J), Harold L. Murphy (J), Andrew Anton Naleway, Jr. (J), Jack Simon (M), Elwin E. Smith (M), Theodore S. Starr (J), Joseph Warrington (A).

Mid-Continent Section

William C. Gass (J), Ted W. Legatski (M), Fritz W. Weilmuenster (M), Jean R. Whitlock (M).

Mid-Michigan Section

James Raymond Reif (J), Robert E. Walker (J).

Milwaukee Section

Edward J. Gaffney (J), William Arthur Riebe (J).

Montreal Section

Philip Baxter (A), Marcel Beaumier (A), Percy R. Dowden (M), Norman Leonard Goddard (J), Jean M. H. Heines (M), Andre Melikoff (M), Clarence Sheppard (A), Charles M. Thomson (A), Reginald A. Wardle (A).

New England Section

John A. Bowler (M), Robert G. DeSilvestri (J).

Northern California Section

Hilmar W. Haenisch (J), Syed V. Husain (J), Saul Mandel (J).

Northwest Section

L. O. Kittelson (M), John R. Nicholas, Jr. (J).

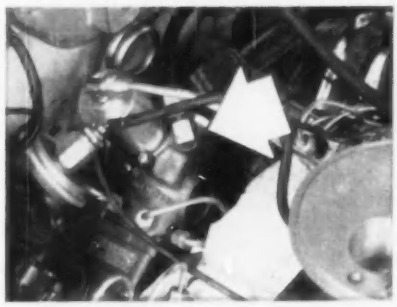
Philadelphia Section

E. N. Alexander (A), Frank E. Anderson (M), Raymond G. Bertles (J), Howard H. McCrea, Jr. (J), Ernest N. Scarborough (M).

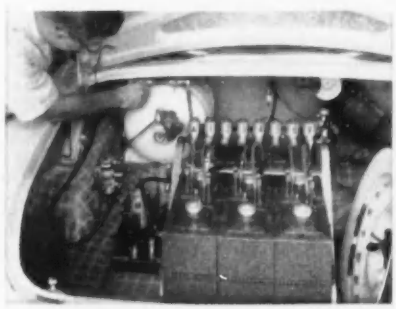
Pittsburgh Section

Cordy M. Russell (J), Russell G. Whittemore (M).

Continued on Page 114



The arrow is pointing to the Du Pont test car's fuel-injection pump, which is driven by the same shaft as the distributor.



From these tanks in the trunk, any of six different fuels can be selected for testing in the fuel-injection engine.

Fuel-injection car being tested on Du Pont Petroleum Laboratory's chassis dynamometer.

Special Du Pont test car studies advantages of *fuel-injection*

Will fuel-injection soon replace our standard carburetor system? As yet, no one knows the answer! But there are certainly many advantages to recommend it . . . such as freedom from carburetor icing, reduction of vapor lock troubles and improved power. And it will permit automobile styling changes since the hood lines can be lowered.

But how would a trend to fuel-injection engines affect the refiner? As a large supplier of the chemical additives used to improve fuel performance, we at Du Pont are interested in this development. And to study it thoroughly, the Du Pont Petroleum Laboratory is using a specially equipped test car.

The car has a Lincoln V-8 engine to which has been added an American Bosch fuel-injection system and special instrumentation. In addition to road work, the Petroleum Laboratory has tested the car on the Laboratory's chassis dynamometer.

From testing it with a variety of gasoline blends, the Laboratory has found that *fuel-injection permits greater flexibility in blending fuels. Fuel components with higher vapor pressures can be used, and it is possible that increases in the use of higher end point fuels may be practical. These wider tolerances could result in significant economic advantages to refiners,* as well as welcome benefits to the motoring public.

The Du Pont Petroleum Chemicals Division now has this car on a demonstration tour throughout the United States.

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continued

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John Lonnie Jones (J), Robert T. Lintern (M), George M. Stonum (J).

San Diego Section

Ralph L. Bayless (M).

Southern California Section

Ichio Egashira (J), Welko E. Gasich (M), William Grayer (J), Roy C. Heacock (M), 1st Lt. Charles Edward Juran (J), Roger E. Lagerquist (J), Paul A. McDonald (J), John T. Pertile (M), E. B. Reynolds (M), Charles G. Romary (J), David D. Ruehlman, Jr. (J), Henry Rust, Jr. (M), Frank Sperl, Jr. (J), William K. Stevenson (A), Edward Woo (A), Robert W. Young (M).

Southern New England Section

John Patrick Beck (J), Mark Goedecke (A), Edward V. Huda (M), Joseph Scianna (J), George A. Smith, Jr. (J), Howard B. Winkler (J).

Texas Section

Allen W. Cain, Jr. (J) Frank J. Carlson (M), Birdell F. Grossman (A), Charles G. Martin, Jr. (M), Preston D. Megginson (A), Glen Duane Snyder (J).

Texas Gulf Coast Section

John Wesley Kelly, Jr. (M), Dane E. Smith (J).

Twin City Section

Harry T. Bratt (M), Neil F. Brown (M), Allan G. Cederberg (M).

Washington Section

George G. Richey (M), Irwin L. Smietan (J).

Western Michigan Section

Curtis E. Behrens (J).

Wichita Section

William A. Swope (J).

Outside Section Territory

Robert L. Allen (M), W. E. Clements (M), Henry W. Cutchin, Jr. (A), Henry D. Kadavy (J), E. F. Meier (J), Philip G. Rector (J), Glen E. Smelcer (J), Glen B. Sorensen (M), 2nd Lt. Theodore Alan Sundin (J), 2nd Lt. Robert J. Tulikangas (J).

Foreign

S. C. Bhattacharyya (M), India; Richard Brett (M), England; Oswald G. Dellacanonica (M), Peru; Rolf Goetze (M), Germany; Vernon E. Gough (M), England; Christian N. Kristoff (M), Australia; E. M. Lemper (M), West Africa; Jagat Narain Malik (M), India; Olov Anders Nordstrom (A), Sweden; Exalt Pinto (M), Pakistan; Edward John Rabson (M), England; Anselmo A. A. Rocha Barros (M), Portugal; Alexander S. Simitch (A), France.

Applications Received

The applications for membership received between October 10, 1955 and November 10, 1955 are listed below.

Alberta Group

Lathrop B. Flintom, Jr.

Atlanta Section

Albert C. Ruehmann, Jr.

Continued on Page 116

Applications Received

continued

Baltimore Section

Robert S. Seligman.

British Columbia Section

Bernard Clarke, Lanny W. Pasternak.

Buffalo Section

Edward Kubic, Frederic J. Watkins.

Canadian Section

G. H. Appel, Robert J. Baker, Raymond L. Cavanagh, Albert L. De Sadeleer, Miles H. Hudspeth, Alexander E. Johnston, Robert L. Mitchell, F. Bruce Pillman, James F. Taylor.

Central Illinois Section

Swayne Garrison, James G. Jennrich, Richard P. Larence, Melvin J. Olson, Kenneth A. Rhoads, William G. Zorn.

Chicago Section

Rudolph H. Cook, Vernon D. Enwald, Roy E. Holmgren, Thomas N. Kasabali, James W. Kelley, Lester J. Larsen, Roger R. Luther, John F. Schott, William G. Talbott, Jeffery L. West, Vincent J. Zegers.

Cincinnati Section

Ernest W. Miller, Jerard M. Pederson.

Cleveland Section

William J. Anderton, Richard R. Azeltine, John J. Brogan, Willard W. Brown, W. H. Chandler, Ralph V. Denman, William C. Hutchings, Roger R. Klatt, William A. Michaels, Donald W. Partain, Paul N. Prass, Harold A. Rippl, Louis J. Schafer, Jr., Walter J. Van Uum, Jr.

Dayton Section

William W. Higham, William R. Lamb, Jr., Thomas J. Lord, John H. Smith, Louis B. Zambon.

Detroit Section

Robert A. Anderson, Frederick J. Beamish, Kenneth J. Belmont, Joseph F. Bertsch, William A. Biddle, James E. Black, A. C. Breitenbeck, Gordon D. Brooks, John Burman, Lawrence J. Cavanaugh, Julius A. Clauss, Jr., Daniel J. Clifford, James H. Cowen, Stephen A. Csorgo, Ernest A. Dacey, Thomas F. Daly, Jr., Arthur P. Dowd, Robert J. Dubuc, Merle B. Easter, N. E. Edlefsen, Eugene V. Fesler, Samuel A. Findley, Donald L. Groves, C. W. Gumbert, James N. Hall, Russell H. Hall-

Applications Received

continued

man, Eugene R. Karrer, Henry Kummerfeld, Alexander J. Lobbestael, Wallace A. Lobdell, Harlan L. MacDowell, S. Austin Marquis, George N. Mattson, Wesley L. McCollum, Bruce McCullough, James L. McCurdy, Howard N. McGregor, Clarence Morgan, C. Charles Mortimore, Richard D. Murphy, Gilbert H. Newbury, Frank M. Parcella, Roy E. Peckham, Thomas K. Pembleton, G. Thomas Poirier, Kenneth I. Postel, Ralph E. Raymond, William Reid, Albert L. Reynolds, Casimir Rogo, John R. Saunders, John A. Schaible, Sydney F. Segal, Zachary W. Smith, Robert J. Spillman, Charles G. Sterling, Howard R. Stevens, Charles B. Stevenson, Dan Russell Test, Yunus Unal, Hang C. Wang, Delvin R. Weiland, H. W. Weinberg, Charles A. Williams, Jr., Martin Wurzer, Jr.

Indiana Section

Charles M. Ellis, Donald J. Hausmann, Charlie M. LaVine, John W. Lubbers, Jr., Thomas I. Monroe, Joseph A. Naughton, Gordon C. Sylliaasen.

Kansas City Section

Carroll Abrams, Walter J. Janczewski.

Metropolitan Section

Robert S. Aries, Alan W. Baum, L. Edward Bunch, W. D. Catterson, James A. Corson, Harold C. Daume, William J. Dunbar, Herbert Erickson, George K. Fischer, David F. Greene, John W. Hyde, Frank P. Iannolo, Stanley Kalikoff, C. Lyndall Knapp, Richard R. Ledesma, Frank M. Lefor, Salvatore J. Mazzarella, Russel R. Mock, Robert A. Paulsen, Murray Rothberg, Betram E. Sealander, George E. Shevlin, Warren M. Spear, Frank J. Tomasek, John L. Webster, Franklin Whitescarver, Stephen L. Wythe.

Mid-Continent Section

H. Dale Jordan, Ronald L. Maier, Howard J. Passage.

Mid-Michigan Section

John H. Christ, John L. Cohoon, Hugh H. Dorman, George A. Edwards, James P. Miller, Jack B. Ridenour.

Milwaukee Section

James E. Braas, James L. Bunda, Lawrence P. Ludwig.

Montreal Section

Albert H. Palmer.

Continued on Page 120

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more torque capacity

plus 50%
more heat resistance

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Clutches take a terrific beating in heavy duty operation on trucks, tractors, bulldozers, graders, shovels, cranes and similar machinery. They've got to be really rugged to stand up under the strain of constant engaging and disengaging, sudden starts and stops, heavy power loads. And the insistent demand is for longer life, more torque capacity, better heat disposal.

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Samuel F. Armour, Raymond L. Cleveland, Richard I. Faunce, William G. Pursell.

Northern California Section

Dwight B. Sale, Carlos M. Valdivia, Jr.

Oregon Section

Charles C. Hamilton, Harry C. Jacobsen, H. C. Palmer, Jack M. Ward, Stanley W. White.

Philadelphia Section

Shirley C. Bartlett, Jr., J. William Blattenberger, Yeates Conwell, John Gattuso, Messoud Kiachif, Rodolphe L. Richard, Philip N. Thomas.

Pittsburgh Section

Gianni A. Dotto, Samuel H. Miller.

St. Louis Section

William R. Humes, Guy A. Turner, Jr.

San Diego Section

Rocco V. Bucciarelli, John D. Donaldson, Elias L. Margolin, Derek A. Shackleton.

Southern California Section

Allan F. Bell, Raymond G. Booth, E. R. Casale, Robert L. Downie, G. A. Fitzpatrick, Robert H. Hadfield, James P. Kaesman, Robert A. Keadle, Paul W. Knaebel, Paul S. McKibben, Milton A. Miner, Frank A. Moody, Charles K. Moore, John F. Peyton, Frederic Neil Smiley, Douglas G. Thompson, Timothy C. Walston, John T. Wilson.

Southern New England Section

Frank O. Hamlet, William M. Letteris, Richard F. O'Donnell, Donald E. Parker.

Syracuse Section

Alex Kerr, Thomas A. Kesel.

Texas Section

Jack B. Callan, Carol C. Carbaugh.

Texas Gulf Coast Section

James A. Ellison, A. W. Elrod, Burton M. Fouts, T. Noah Smith, Jr.

Twin City Section

Glenn R. Anderson, Robert W. Carlson.

Virginia Section

William I. Bragg, William I. Ivey, Jr.

Washington Section

Walter K. Allen.

Western Michigan Section

Hubert Lee Childers, Ralph P. Lillmars, Sidney E. Miller.

Wichita Section

Donald L. Fowler, Ross S. Philips.

Outside of Section Territory

W. R. Alford, Luther C. Butler, Jack E. Cooper, David C. Howard, Jr., Robert L. Hughes, Robert D. Johnson, James E. Kerwin, Sr., Harold Rees, Jerome R. Susag.

Foreign

Joachim Arendt, Germany; William A. Bruinsma, Saudi Arabia; Karlheinz Ern, Germany; George Ewdokimoff, Argentina; Heinz Hoffman, Germany; Meduri N. Muralikrishna, India; John M. Nuttall, Germany; Vernon O. S. Peckham, England.

With the touch of a finger...

sea level comfort for The Golden Falcon

Aboard Eastern Airlines new DC-7B Golden Falcons the flight engineer can create maximum pressurized comfort with a touch of a finger. A new AiResearch cabin pressure control system makes this possible.

Working with Douglas engineers, AiResearch designed a pneumatic butterfly outflow valve for the Eastern DC-7B fleet. The outflow valve was developed for a ducted installation and is connected by a small air line to a lightweight AiResearch controller located at the flight station. The new valve permits cabin pressure to be *its own source of power* — the basic pneumatic principal of all AiResearch pressurization systems.

Eastern Airlines reports that the new system has already passed the 1000 hour mark of trouble free operation and that passenger reaction has been most favorable. Dependability, compactness and easy maintenance are other features which made this integrated system a must for Eastern's new DC-7B's. In the field of integrated aircraft systems and specialized components AiResearch has more experience than any other company.

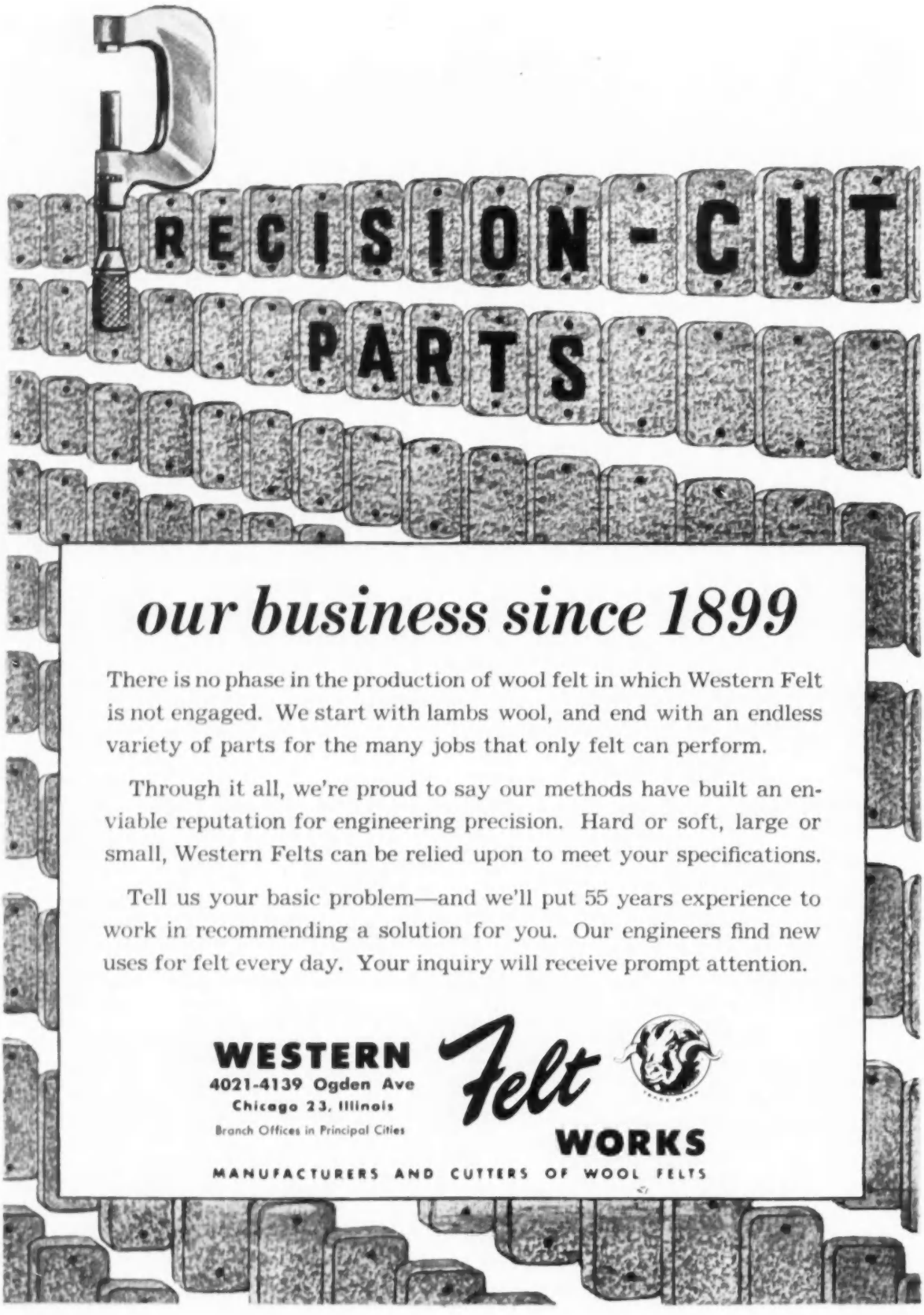
Qualified engineers in the fields listed below are needed now. Write for information.

THE GARRETT CORPORATION

AiResearch Manufacturing Divisions

Los Angeles 45, California • Phoenix, Arizona

Designers and manufacturers of aircraft systems and components: REFRIGERATION SYSTEMS · PNEUMATIC VALVES AND CONTROLS · TEMPERATURE CONTROLS · CABIN AIR COMPRESSORS · TURBINE MOTORS · GAS TURBINE ENGINES · CABIN PRESSURE CONTROLS · HEAT TRANSFER EQUIPMENT · ELECTRO-MECHANICAL EQUIPMENT · ELECTRONIC COMPUTERS AND CONTROLS



our business since 1899

There is no phase in the production of wool felt in which Western Felt is not engaged. We start with lambs wool, and end with an endless variety of parts for the many jobs that only felt can perform.

Through it all, we're proud to say our methods have built an enviable reputation for engineering precision. Hard or soft, large or small, Western Felts can be relied upon to meet your specifications.

Tell us your basic problem—and we'll put 55 years experience to work in recommending a solution for you. Our engineers find new uses for felt every day. Your inquiry will receive prompt attention.

WESTERN
4021-4139 Ogden Ave
Chicago 23, Illinois
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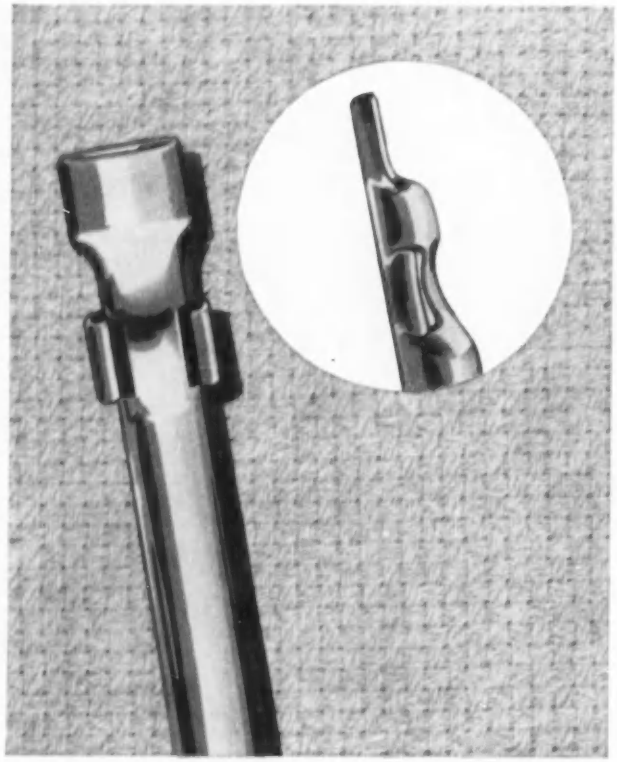
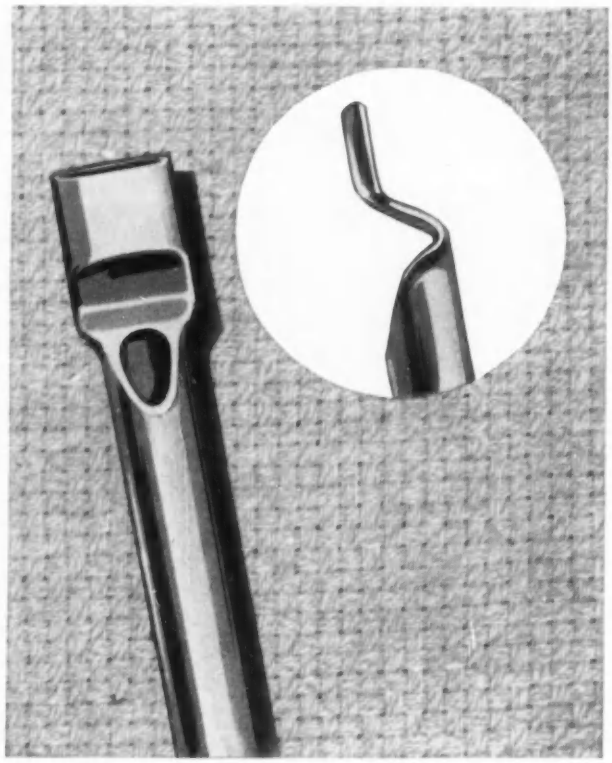
Felt **WORKS**

MANUFACTURERS AND CUTTERS OF WOOL FELTS





It almost goes without saying that leakproof Bundyweld can be depended on for reliable performance. It is axiomatic, too, that Bundyweld takes easily to intricate fabrication steps. Above, left, vent tube for use inside gasoline filler tube presented a problem: how to remove possibility of gasoline entering two side vents as gas tank was filled. New design suggested by Bundy completely protects vent from gasoline entry by baffle deflection; requires two fabrication operations: one to flatten end and pierce tube simultaneously, one to put double bend in flattened part.

Skip the trial-and-error process--change to Bundyweld now!

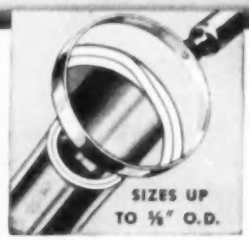
WHY BUNDYWELD IS BETTER TUBING

Bundyweld starts as a single strip of copper-coated steel. Then it's . . .

continuously rolled twice around laterally into a tube of uniform thickness, and

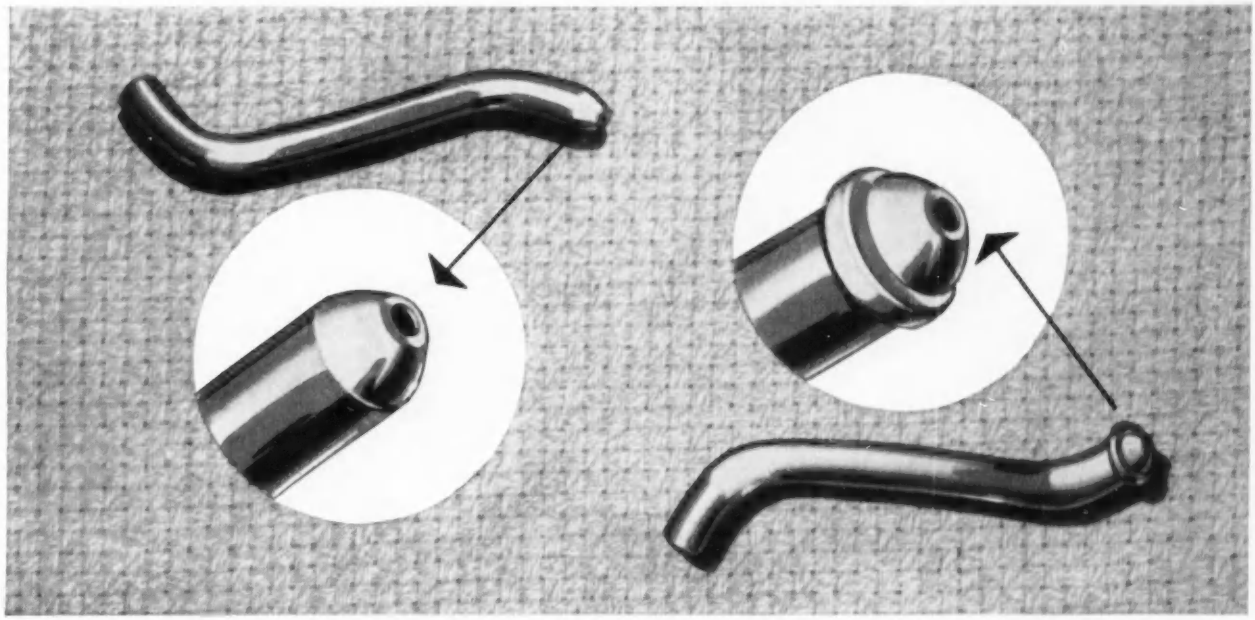
passed through a furnace. Copper coating fuses with steel. Result . . .

Bundyweld, double-walled and brazed through 360° of wall contact.



←

NOTE the exclusive Bundy-developed beveled edges, which afford a smoother joint, absence of bead and less chance for any leakage.



Another example of the ease with which Bundyweld is fabricated: the 3/16" O.D. timing-gear oiler tube shown above required tapered end for a nozzle effect, meant numerous swaging operations. Bundy added upset to nozzle tip (right), incorporated two hand-bending operations into one automatic press operation. Result: impressive fabrication savings.

Maybe you've found a tubing that's somewhat reliable for your automotive brake lines, oil lines, gasoline lines, other tubing needs — *except that it has a mind of its own during fabrication.*

Or perhaps you've dug up a tubing that handles fairly easily — *but you can't count on it for reliable performance.*

You're still looking for the *right* tubing.

We suggest that your search for a reliable, easily fabricated tubing will eventually lead you to Bundyweld. (Reminder: Bundyweld is used in 95% of today's cars in an average of 20 applications each.)

Why not skip the trial-and-error process — wasted time, delivery delays, expensive research, possible damage to your product reputation. Why not measure Bundyweld against your needs *right now.*

Bundyweld is leakproof by test; thinner walled yet stronger; has high thermal conductivity, high bursting strength; takes easily to standard protective coatings; has high fatigue limits. It's the only tubing double-walled from a single metal strip; copper-brazed throughout 360° of double-walled contact.

In addition, Bundy offers you unexcelled fabrication facilities, expert engineering services; custom-packaging of orders; prompt, *on-schedule* deliveries. Whether you fabricate your own parts or want us to do the job, we're equipped to handle your order — *exactly to your satisfaction.*

Why not turn your tubing headaches over to our staff of engineering experts now. They specialize in solving tricky problems, look forward to helping you with yours. Call, write or wire us for information or for help with your problem.

BUNDY TUBING COMPANY, DETROIT, MICHIGAN

BUNDYWELD TUBING®

DOUBLE-WALLED FROM A SINGLE STRIP

Bundy Tubing Distributors and Representatives: *Cambridge 42, Mass.:* Austin-Hastings Co., Inc., 226 Binney St. • *Chattanooga 2, Tenn.:* Pairson-Deakins Co., 823-824 Chattanooga Bank Bldg. • *Chicago 32, Ill.:* Lapham-Hickey Co., 3333 W. 47th Place • *Elizabeth, New Jersey:* A. B. Murray Co., Inc., Post Office Box 476 • *Los Angeles 58, Calif.:* Tubesales, 5400 Alcoa Ave. • *Philadelphia 3, Penn.:* Rutan & Co., 1717 Sansom St. • *San Francisco 10, Calif.:* Pacific Metals Co., Ltd., 3100 19th St. • *Seattle 4, Wash.:* Eagle Metals Co., 4755 First Ave., South *Toronto 5, Ontario, Canada:* Alloy Metal Sales, Ltd., 181 Fleet St., E. • **Bundyweld nickel and Monel tubing are sold by distributors of nickel and nickel alloys in principal cities.**

Packard's large staff of experienced engineers is at your service to help solve cable problems most efficiently. And when the problems are solved and your needs determined, Packard Electric—with facilities for the daily production of more than 7,000,000 feet of cable and 800,000 wiring assemblies—will assure you dependable, on-time delivery.

Consider Packard as a source

Packard cable and wiring harnesses meet or exceed applicable specifications. They have proved themselves time and again in meeting and standing up to the most exacting demands in automotive and aircraft service. Packard Electric's experience, skill and productive ability often result in substantial savings to customers. Possibly the savings to you could be substantial too.

GM GENERAL MOTORS Packard

REG U.S. PAT. OFF.

Packard Electric Division, General Motors, Warren, Ohio
Offices in Detroit, Chicago, and Oakland, California

AVIATION, AUTOMOTIVE AND APPLIANCE WIRING

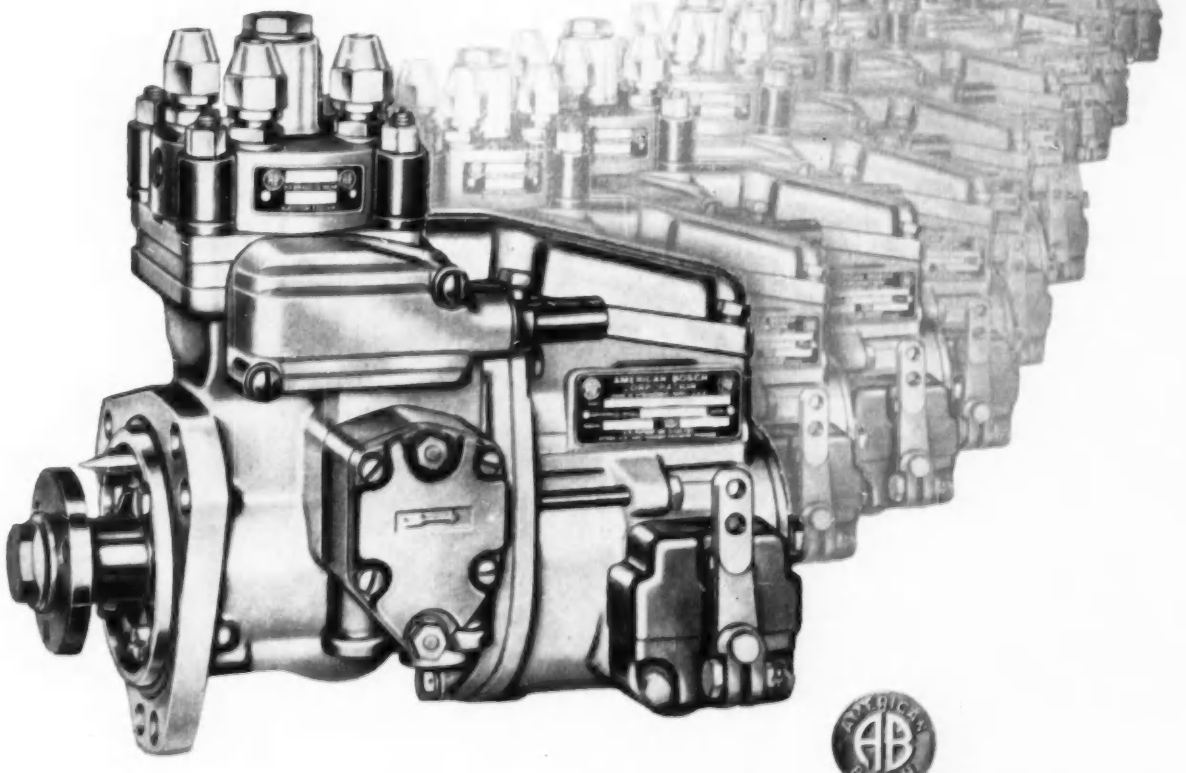
over 100,000...and STILL GROWING

Now over 100,000 American Bosch PSB injection pumps have been produced for the Diesel Industry.

This record, established in the space of just a few years, proves conclusively the wide acceptance of this simplified, distributor type pump.

Today, more Diesel engine manufacturers than ever before are using the American Bosch PSB as standard equipment on the smaller Diesels that power farm tractors, compressors, generating sets, boats and trucks in ever-increasing numbers.

The American Bosch PSB has an outstanding record of performance and dependability—assuring users everywhere of long trouble-free service and low maintenance expense. It stands as a significent contribution to the progress of the Diesel engine. American Bosch, Springfield 7, Massachusetts.



AMERICAN BOSCH

DOEHLER-JARVIS DIVISION

OF NATIONAL LEAD COMPANY

GENERAL OFFICES

TOLEDO 1, OHIO

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PLANTS AT
BATAVIA, N. Y.
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RT	RT
CD	
RL	RL
AC	AC
EM	EM
TG	TG

General Manufacturing Co., Inc.
1957 Plant St.
Middletown, U.S.A.

Att.: Chief Design Engineer

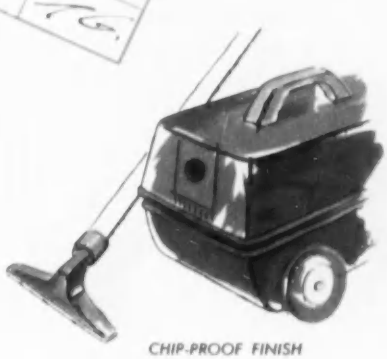
Dear Sir:

Here's something new...

Now you can have bright anodized aluminum parts that match chrome plate almost exactly for brilliance, color and tone.

CD
This is news!
RL

Or you can have these parts in rich golds, peacock blues, deep crimsons...any color or tone you wish...with lusters from a bright high polish to a soft satin. No chipping. No peeling. Top notch resistance to wear, weather, corrosion.

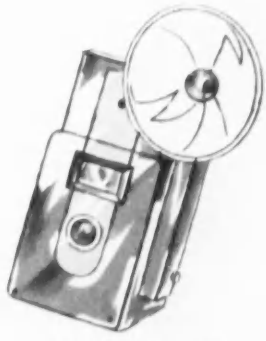


CHIP-PROOF FINISH

You can have any aluminum part bright anodized, whether stamped, forged, drawn, or extruded.

Already designers are seizing the idea...

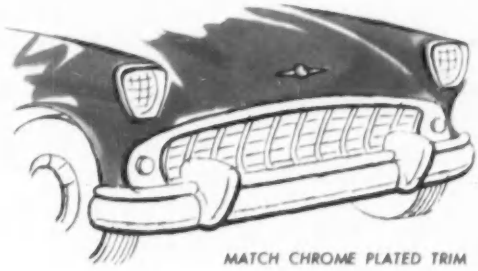
For instance, gay frames for eyeglasses are now bright anodized. So are exciting new coffee makers...and a number of colorful houseware items.



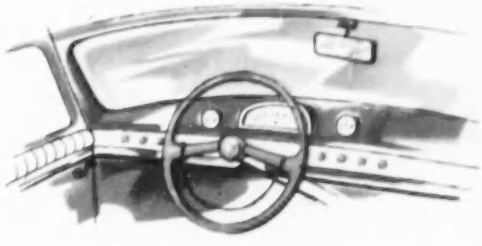
ACID RESISTANT AND NON-FADING

That's only the beginning. Bright anodized aluminum is replacing heavy chrome plated grilles in several style-setting new automobile models now in production or planned. The blend with chromed body trim and bumpers is said to be perfect...cost and front-end weight much lower.

Maybe this will answer that problem we discussed at lunch yesterday.



MATCH CHROME PLATED TRIM



BLEND WITH INTERIOR UPHOLSTERY

In the appliance field, one leading range maker is bright anodizing control knobs and emblems. And bright anodizing is also being used to re-style refrigerator and other kitchen appliance hardware...in color.

So it goes. Think what might be done to give dash boards new dash! And maybe we'll soon see a car "gold-trimmed" throughout. We've sketched other possibilities and you'll think of more -- instrument bezels, tubular furniture, window frames, perhaps. TV sets? Cameras?

Sets take a new look at our whole line

And your products? Doehler-Jarvis is ready to stamp, forge, extrude, or draw aluminum parts and bright anodize them for you. Maybe, too, we can give an "assist" on design.

A Doehler-Jarvis sales engineer will be glad to meet with you anytime. Just say the word.

Sincerely,

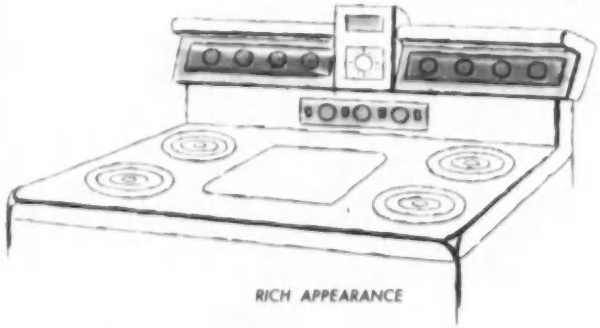
Doehler-Jarvis Division
National Lead Company

I'll be in Chicago this week. See if you can set something up for the week following.
RT

NON-TARNISHING

RAINBOW-WIDE COLORS

NON PEELING



RICH APPEARANCE

DOEHLER-JARVIS DIV. OF NATIONAL LEAD COMPANY

TOLEDO 1, OHIO

On **CATERPILLAR**-Built Tractors . . .
VICTOR Sealing makes a power-full difference

Quality Sealing Products for Every Vital Point

- VICTOPAC
- VICTOR HEAD GASKETS
- VICTOLEX
- VICTOPRENE OIL SEALS
- VICTORITE
- VICTOR MANIFOLD GASKETS

Put the recommended Caterpillar machine on a job . . . and it packs plenty of reserve power under all conditions. Because every ounce of power these mighty machines produce is sealed-in for delivery to the drawbar.

Carefully engineered, long-life gaskets and oil seals prevent undue loss of compression, lubricants, coolant and hydraulic operating fluid. Caterpillar specifications require quality in sealing parts—and that makes this power-full difference.

Victor sealing is quality sealing—for all types of automotive, earth-moving, marine, industrial and agricultural machinery. Continuing research and development by Victor assure you of the best sealing materials . . . the widest choice for every need . . . and each Victor packing is clearly defined and classified by ASE-ASTM specifications.

Skill in product engineering, multiplying ever since 1909, and the industry's foremost production facilities complete your satisfaction when you seal with Victor.

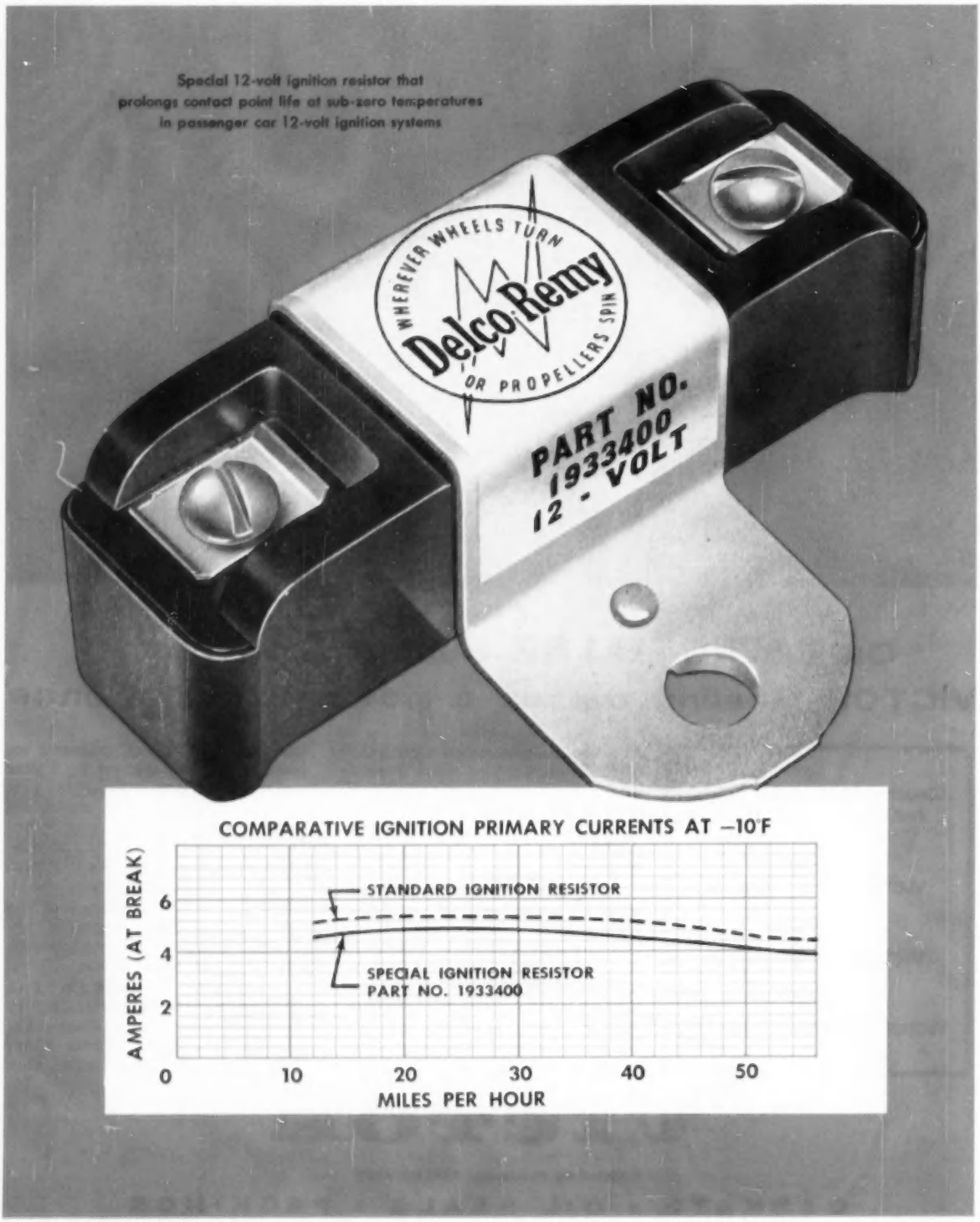
Victor Mfg. & Gasket Co., P.O. Box 1333, Chicago 90, Ill. In Canada: Victor Mfg. & Gasket Co. of Canada Limited, Victor Drive and Chester St., St. Thomas, Ont.

VICTOR

Sealing Products *EXCLUSIVELY*

GASKETS • OIL SEALS • PACKINGS

Progressive Engineering



Makes the Difference

SPECIAL DELCO-REMY 12-VOLT RESISTOR PROTECTS IGNITION POINTS EVEN IN PROLONGED SUB-ZERO WEATHER

The *engineered* answer to sub-zero weather starting problems resulting from burned distributor contact points in Delco-Remy 12-volt passenger car ignition systems is the new Delco-Remy No. 1933400 special ignition resistor.

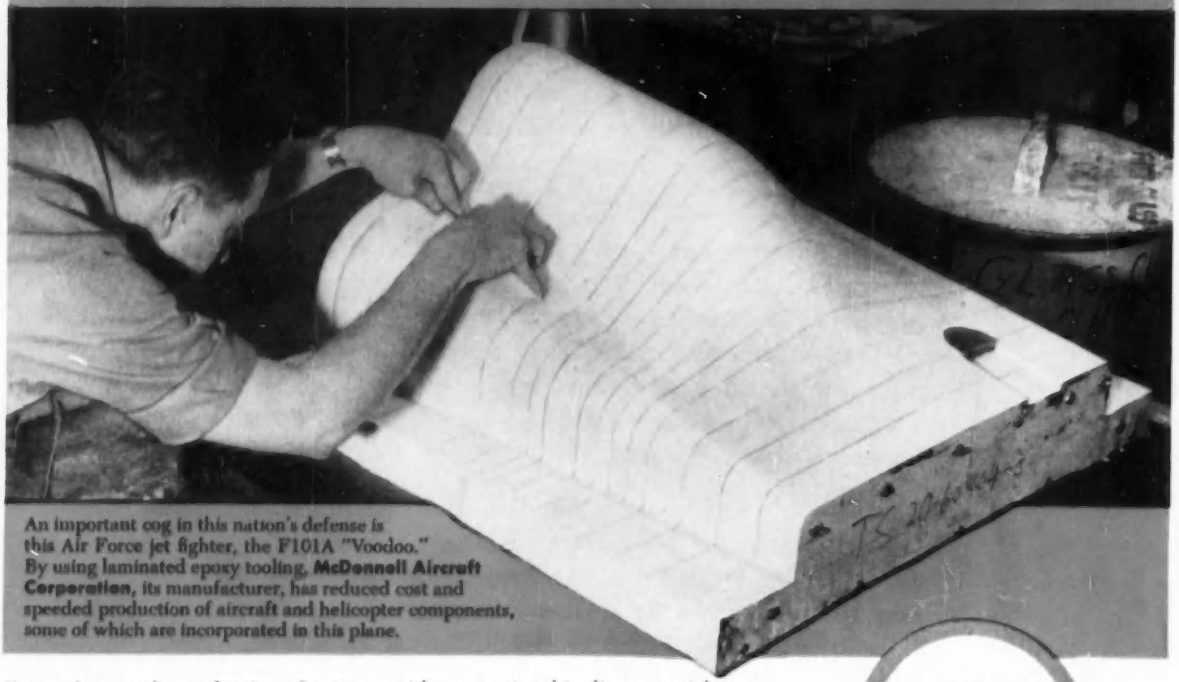
This special-duty unit solves such problems *at the source* by protecting contact points from the abnormally high primary currents which often occur during prolonged, extremely cold weather. With a No. 1933400 resistor on the job, contact points stay clean and continue to operate at summertime efficiency even in sub-zero weather, assuring easier starting, better ignition, longer point life.

Through such developments resulting from constant study of service problems, Delco-Remy is always abreast—often ahead—of developments in the automotive industry. Whenever the need arises for further advances in automotive electrical equipment, count on Delco-Remy to be ready.

Delco-Remy
ELECTRICAL SYSTEMS

DELCO-REMY, DIVISION OF GENERAL MOTORS, ANDERSON, INDIANA

Compounds based on BAKELITE Epoxy Resins cut production costs, tooling time!



An important cog in this nation's defense is this Air Force jet fighter, the F101A "Voodoo." By using laminated epoxy tooling, **McDonnell Aircraft Corporation**, its manufacturer, has reduced cost and speeded production of aircraft and helicopter components, some of which are incorporated in this plane.

Faster, less costly production of interchangeable aircraft components results from the advantages of "Ren" tooling compounds based on BAKELITE Brand Epoxy Resins. For instance:

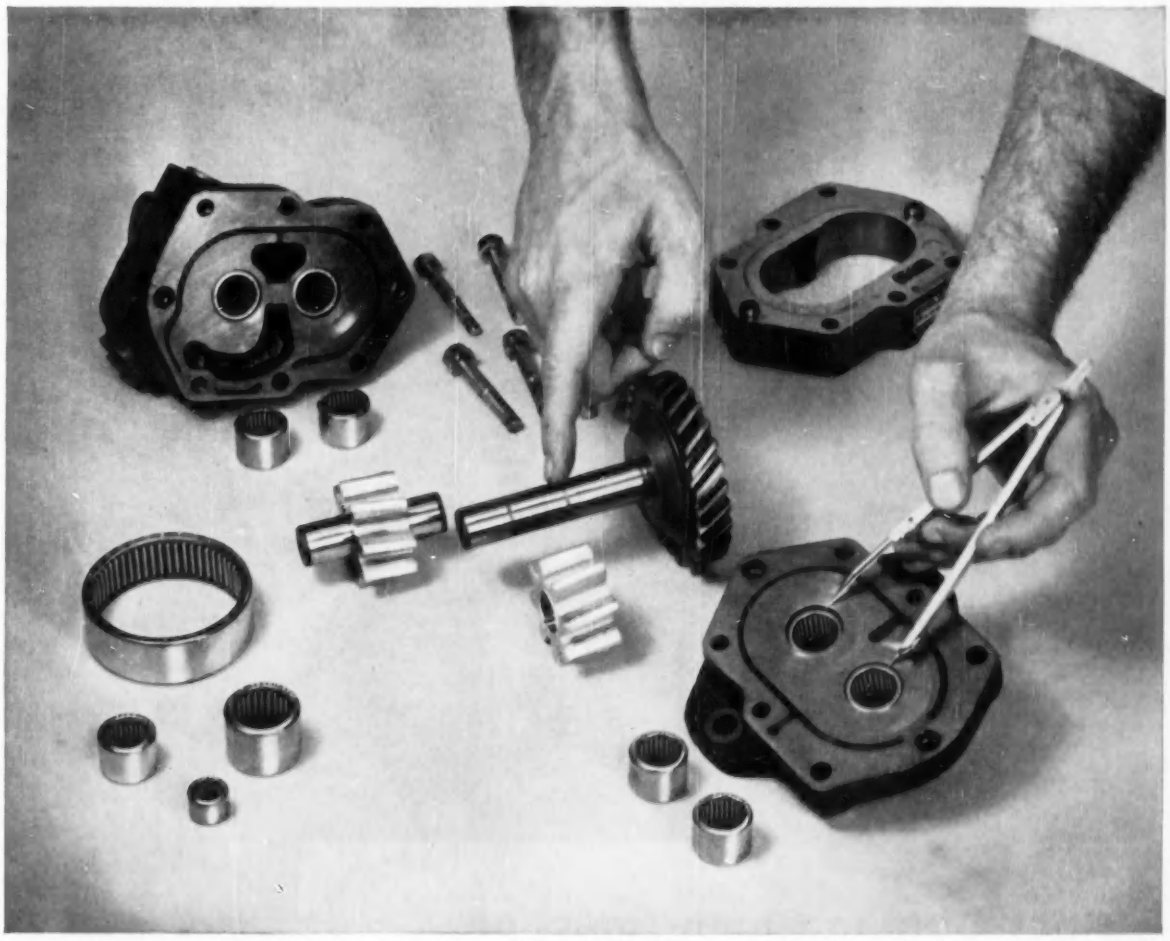
- Overall savings as high as 40 per cent have resulted where tools are adaptable to plastic.
- Weight of plastic tools is only 25 per cent that of similar steel or kirksite tools, 60 per cent that of aluminum tools.
- Savings in tooling-up time are as much as 40 per cent when compared with conventional tooling materials.
- Up to 75 per cent of all the interchangeable door panels used in one aircraft have been assembled and coordinated with tools made of BAKELITE Epoxy Resin—glass cloth laminates.

Epoxy plastic tooling compounds enabled this aircraft manufacturer to take advantage of the savings cited above. The compounds that are used are a product of **Ren Plastics, Inc.** (formerly Ren-ite Plastics, Inc.), P. O. Box No. 1256, Lansing 4, Mich.

BAKELITE BRAND EPOXY RESINS

BAKELITE COMPANY, *A Division of Union Carbide and Carbon Corporation* UCC 30 East 42nd Street, New York 17, N. Y.

The term BAKELITE and the Trefoil Symbol are registered trade-marks of UCC



Hydraulic Gear Pump—product of Webster Electric Company, Racine, Wis.

"You can use bigger shafts with
TORRINGTON NEEDLE BEARINGS"

How to achieve a bearing assembly of minimum size while maintaining maximum shaft rigidity—that's a puzzler that many a design engineer has had to sweat out.

The Torrington Needle Bearing—because of its unique unit construction—has helped solve that problem in literally thousands of products throughout industry where it has become "standard equipment."

With its full complement of small diameter rollers, the Needle Bearing offers greater radial load capacity than any other anti-friction bearing of the same size. And because of its thin section, it permits the use of larger shafts to minimize deflection.

In addition, a Needle Bearing needs no inner race when running on a properly hardened shaft.

For twenty years our Engineering Department has helped designers and manufacturers to adapt the unique advantages of the Needle Bearing to their products. Let us help you with your anti-friction problems.

See our new Needle Bearing Catalog in the 1955 Sweet's Product Design File —or write direct for a catalog.

THE TORRINGTON COMPANY
Torrington, Conn. • South Bend 21, Ind.

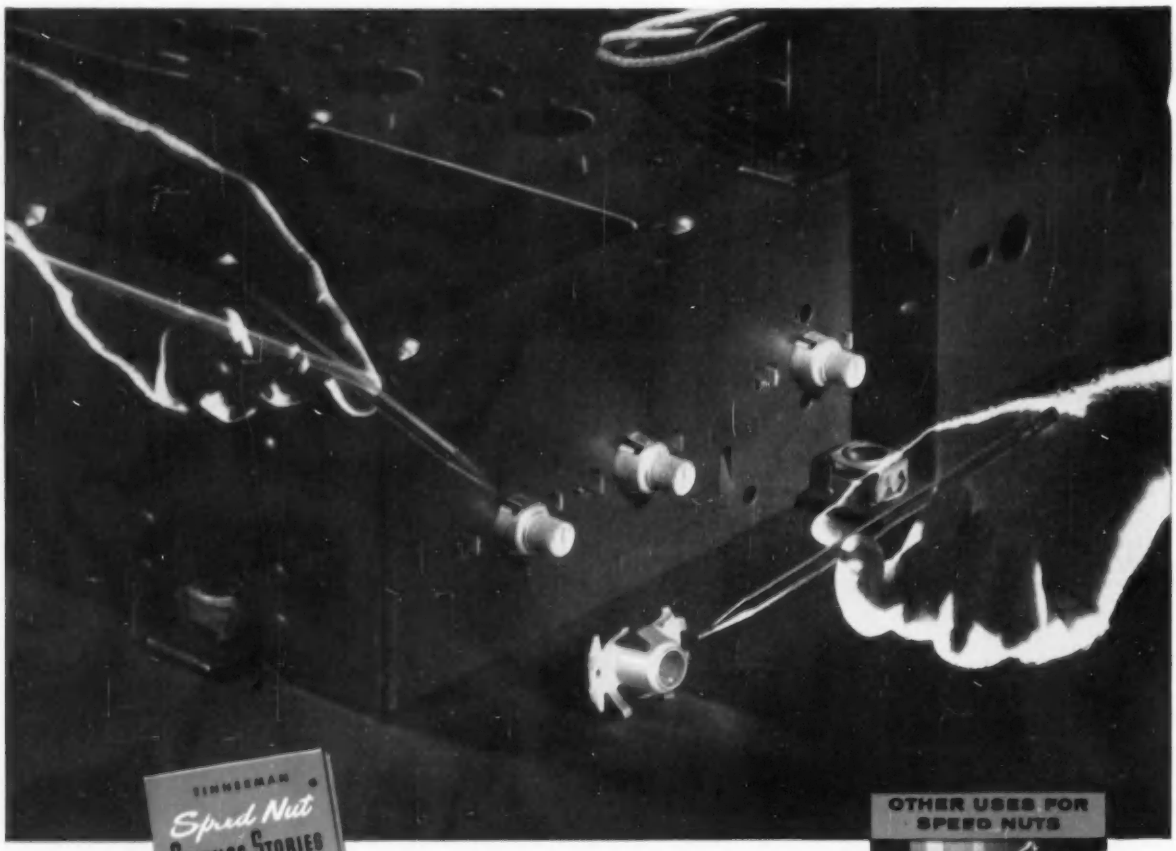
District Offices and Distributors in Principal Cities of United States and Canada

TORRINGTON *NEEDLE* **BEARINGS**

Needle • Spherical Roller • Tapered Roller • Cylindrical Roller • Ball • Needle Rollers

These features make the **TORRINGTON NEEDLE BEARING** *unique*

- low coefficient of starting and running friction
- full complement of rollers
- unequalled radial load capacity
- low unit cost
- long service life
- compactness and light weight
- runs directly on hardened shafts
- permits larger and stiffer shafts



TINNERMAN Speed Nut SAVINGS STORIES

Cost-Cutting Chain Reaction Triggered by SPEED CLIP®!

Savings for the parts supplier, the television manufacturer and the ultimate user! That's the triple play that begins every time Centralab, division of Globe Union, Inc., Milwaukee, Wis., assembles a "Snap-Tite" television control. Here's why: There's a job-engineered Tinnerman SPEED CLIP in every control assembly.

A simple two-at-a-time hand operation speeds assembly of controls to chassis for an amazing 73 per cent savings in time. No special skills or tools are required. Spring steel fingers of the SPEED CLIP snap past the panel as inserted . . . hold the controls firmly in place and automatically spaced away from the chassis. Removal for service is simply a matter of pinching the spring fingers inward and slipping the control free.

Another example of Tinnerman fastening know-how, this part is just one of more than 8,000 SPEED NUT brand fasteners designed to make standard or complex attachments. SPEED NUTS can bring savings to you, too. See your Tinnerman representative soon and write for your copy of "SPEED NUT Savings Stories".

TINNERMAN PRODUCTS, INC. • BOX 6688, DEPT. 12, CLEVELAND 1, OHIO

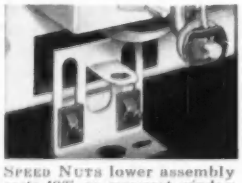
Canada: Dominion Fasteners, Limited, Hamilton, Ontario. *Great Britain*: Simmonds Aerocessories, Limited, Treforest, Wales. *France*: Aerocessoires Simmonds, S. A., 7 rue Henri Barbusse, Levallois (Seine). *Germany*: Hans Sickinger GmbH "MECANO", Lemgo-i-Lippe.

TINNERMAN Speed Nuts® FASTEST THING IN FASTENINGS®

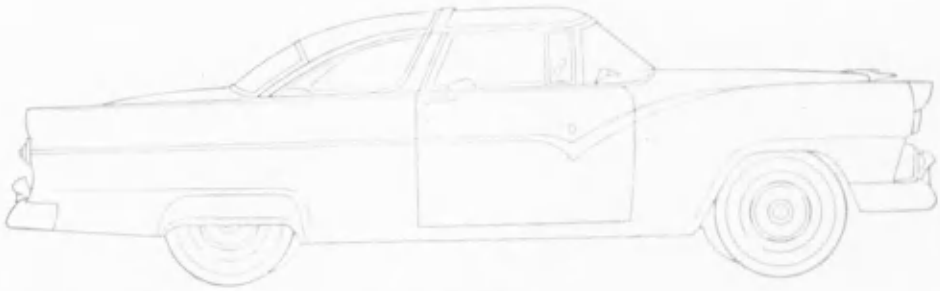
OTHER USES FOR SPEED NUTS

Special SPEED CLIP gives desks extra model flexibility and saves money.

Adjustable awning assembled in 63% less time with special SPEED NUTS.

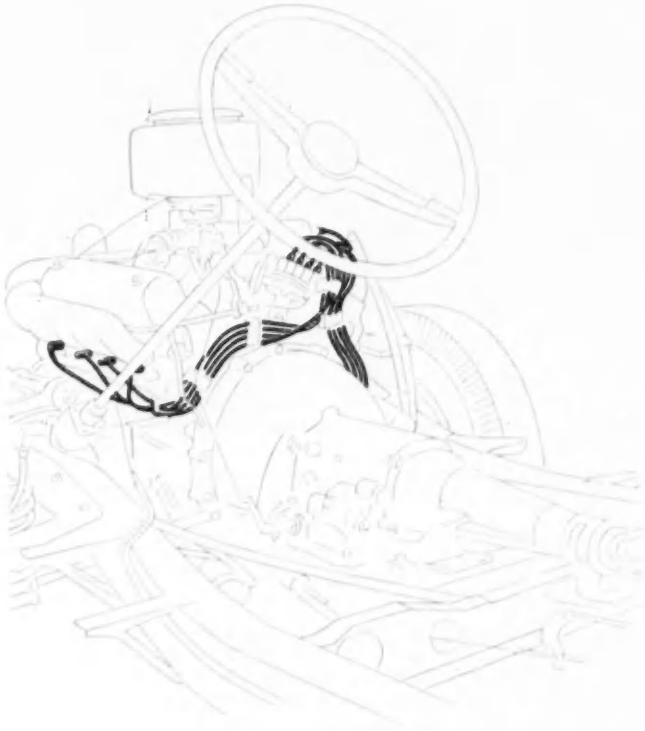


SPEED NUTS lower assembly costs 40% on casement-window air conditioner.



Under the hood of the smart new Ford . . .

Neoprene protects ignition wire and spark plugs against moisture . . . resists ozone, heat and oil



Designers made sure the smart-looking 1955 Ford would be off to a fast start in any weather. On both the "Six" and the "Eight" they chose spark-plug covers and ignition-wire jackets made with neoprene for positive protection against moisture and deterioration.

Neoprene covers prevent seepage of moisture to the spark plugs . . . provide instant, all-weather action. And the sturdy neoprene jacket on the ignition wire protects the insulation against heat and oil.

Moreover, neoprene stays on the job . . . has what it takes to give long, dependable service. It resists ozone and other effects of corona discharge . . . remains firm and strong despite heat, oil and grease . . . won't chip, crack or soften.

Each year finds more automotive parts and accessories made with neoprene, Du Pont's chemical rubber. Because it stands up where ordinary resilient materials fail, neoprene is first choice among designers for key parts that improve performance . . . rarely need replacement.

Free! The Neoprene Notebook

Each issue shows you how designers created new products...improved old ones with neoprene. Actual case histories give you all the facts. Mail coupon below to get on mailing list.

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E. I. du Pont de Nemours & Co. (Inc.)
Elastomers Division SA-12
Wilmington 98 Delaware

Please put my name on the mailing list for the Neoprene Notebook

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NEOPRENE

The rubber made by Du Pont since 1932

DU PONT

BETTER THINGS FOR BETTER LIVING . . . THROUGH CHEMISTRY

The Problem Jobs GO TO AETNA

SPECIAL PROPERTIES

- Stabilized ball races
- Stabilized, super-precision balls
- Matched assembly
- Magnaflux inspected
- Rust preventive finish

Standard and Special Ball Thrust Bearings • Angular Contact Ball Bearings • Radial Ball Bearing Mounted Units • Special Roller Bearings • Ball Retainers • Hardened and Ground Washers • Sleeves • Bushings • Miscellaneous Parts

HERE'S A BUSY BEARING purposely designed to wobble as it works—to eccentrically transmit pumping power to the pistons of one of aviation's foremost fuel injection pump and control assemblies. It's a hard working key component demanding the unerring operational efficiency and dependability so vital to safety in the air.

To assure this reliability, every detail of this "wobble-plate" bearing must measure up to uncompromising specifications—in surface finish . . . in base flatness, parallelism and face angularity . . . in the hardness, stability and grain structure of its steel parts.

It takes something extra, something more than physical plant facilities to master today's special bearing problems and property requirements. That's why industry's leaders put more and more of their anti-friction problem-jobs up to Aetna. What interests them is not only Aetna's matchless experience, skill and special interest in such jobs, but also Aetna's proven ingenuity in innovating production and control methods to make them better, faster and at prices that are right.

Our staff of engineers, metallurgists and designers can help you too—from the inception of your ideas or problems to the final answers and applications of special ball bearings, roller bearings and miscellaneous bearing-type parts. A note from you will bring prompt action.

AETNA BALL AND ROLLER BEARING COMPANY

Division of Parkersburg-Aetna Corporation

4602 Schubert Avenue • Chicago 39, Illinois

In Detroit: SAM T. KELLER, 2457 Woodward Ave.

On the production line in a large midwest automatic transmission plant, a Johnson bearing is pressed into the rear pump housing.

Johnson Bearings Help Maintain Long Service Life In Automatic Transmissions

The long, trouble-free service enjoyed by owners of automatic transmissions produced in this large midwest plant stems from the exacting quality control of all components and operations.

For example, the assembly and testing rooms are air-conditioned and dust-proof. There is no smoking permitted in these rooms. Special care is taken to prevent dust from getting into the transmission. All machines are wiped with lintless rayon cloths. Even the floors of these rooms are coated with oil to keep down dust.

With such close attention to every detail it is easy to understand why Johnson was selected as one supplier of the steel backed bearings, both copper alloy and babbitt lined, used in the assembly. Johnson takes great pains in the manufacture of these bearings to assure that these critical parts will be made of an alloy that is consistent in composition and that the bearings are uniform in size and surface finish.

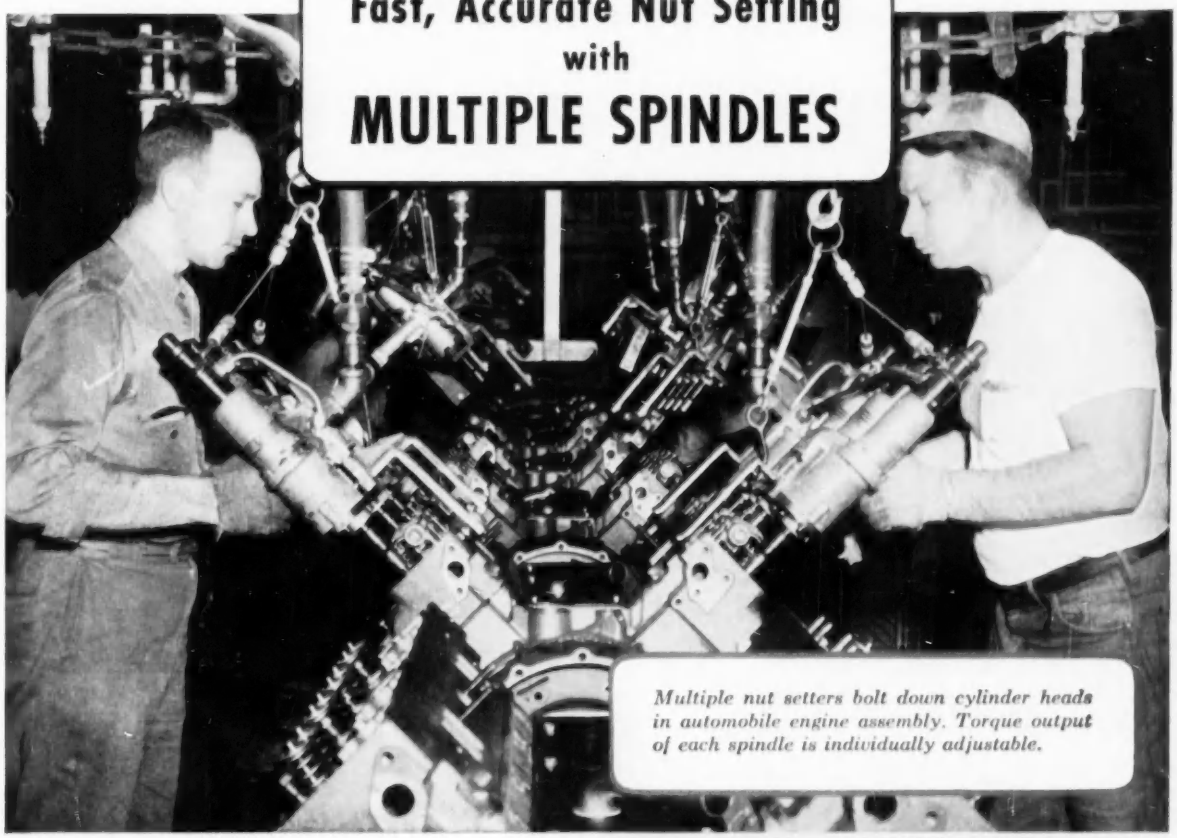
That's why the coordinator of engineers in this plant reports, "Our assembly lines have never had that first bit of trouble with Johnson bearings. Johnson service is good, too—since our factory buys supplies at a lead time of 10 to 60 days, good service means everything in mass production timing."

This fine acceptance of Johnson quality and service is not unusual in the automotive field, for Johnson is an important supplier of main, cam and rod bearings, and bearings for practically every other component in the modern car, truck or diesel engine made today. To learn more about Johnson quality and service, ask one of our engineers to call. Johnson Bronze Company, 625 S. Mill Street, New Castle, Pa.

SEE US IN BOOTH 27 S.A.E. ENGINEERING DISPLAY

Johnson Bearings

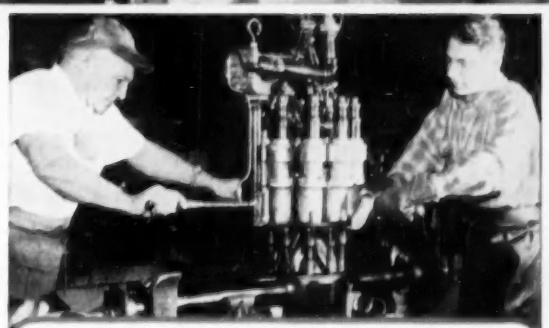
Fast, Accurate Nut Setting with MULTIPLE SPINDLES



Multiple nut setters bolt down cylinder heads in automobile engine assembly. Torque output of each spindle is individually adjustable.

Where bolts or nuts can be run and tightened two or more at a time, Keller Multiple Nut Setters increase output and reduce costs. Even more important, they improve quality control by keeping torque within very close tolerances.

The automotive industry—and many others—are making extensive use of these tools. For detailed information contact your nearest Keller sales office. Descriptive Bulletin 16-101 sent free on request.

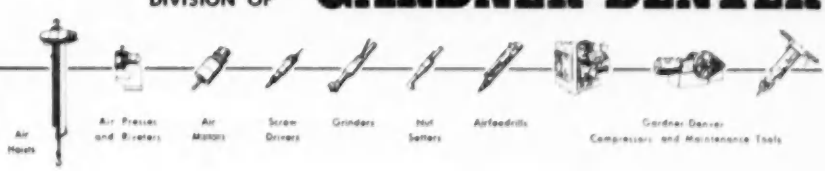


Ten bolts are run simultaneously to attach axle carrier to differential housing. Accurate torque is vital because the joint must be leakproof.

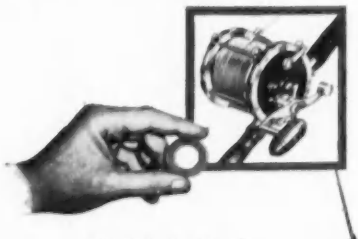
KELLER TOOL

DIVISION OF **GARDNER-DENVER**

GRAND HAVEN, MICHIGAN



Boating a world's record Marlin...



1525-lb. Marlin, the women's world's record, caught by Miss Kimberly Wiss on a Penn Senator Reel with friction drag using J-M Style #600 lining.

or stamping out auto parts...

Two-story high Danly unit for stamping automobile parts using J-M Clutch Disc Inserts.

Equipment can be controlled more efficiently with J-M Asbestos Friction Materials

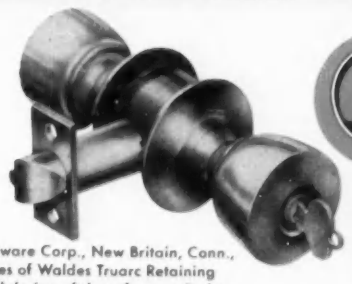
Johns-Manville Asbestos Friction Materials meet a wide range of applications. Whether you need a tiny brake material for a fishing reel . . . or a rugged clutch facing for a powerful machine press, Johns-Manville can help you.

Precision manufactured, dependable Johns-Manville Friction Materials are available in low, medium and high friction coefficients. These linings and facings are specially engineered to withstand severe shock, maintain friction stability under critical temperatures, provide smooth action at a low rate of wear. If your requirements demand a friction material that must be custom-made for a special use . . . the Johns-Manville Research facilities are available to help develop that just-right formulation.

Whatever your friction material problem, the J-M Friction Materials Specialist is at your service. Or, write for reference booklet that contains a complete description of J-M Friction Materials and a handy selector chart. Address Johns-Manville, Box 60, New York 16, N. Y. In Canada, Port Credit, Ontario.

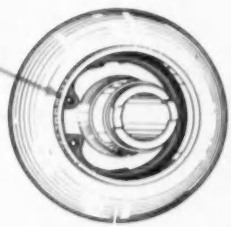
Johns-Manville INDUSTRIAL FRICTION MATERIALS

Waldes Truarc Retaining Rings Eliminate Machining— Provide Stronger Assembly, Greater Accuracy



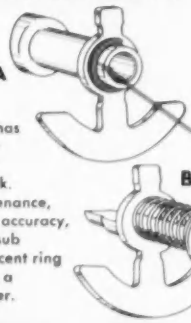
The American Hardware Corp., New Britain, Conn., uses 4 different types of Waldes Truarc Retaining Rings in the original design of these famous Corbin and Russwin Heavy Duty Cylindrical Locks. Truarc rings improve product performance, eliminate rejects, and cut labor costs.

Knob Sub Assembly



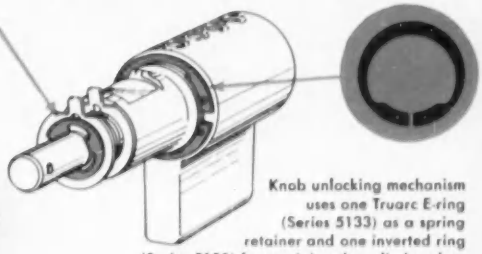
Truarc Beveled Ring (Series 5002) couples the knob to the knob shank. It eliminates two tapped holes and two screws, provides stronger assembly and greater accuracy. Beveled ring takes up end play rigidly.

Spindle Sub Assembly



Spindle sub assembly "A" has two Waldes Truarc crescent rings (Series 5103) used as locating flanges for rollback. This saves labor and maintenance, improves performance and accuracy, eliminates rejects. Spindle sub assembly "B" uses one crescent ring as a spring retainer and as a locating shoulder for washer.

Cylinder Sub Assembly



Knob unlocking mechanism uses one Truarc E-ring (Series 5133) as a spring retainer and one inverted ring (Series 5108) for retaining the cylinder plug. Rings are re-usable in the event of disassembly for maintenance. Rejects are eliminated.

Whatever you make, there's a Waldes Truarc Retaining Ring designed to improve your product...to save you material, machining and labor costs. They're quick and easy to assemble and disassemble, and they do a better job of holding parts together. Truarc rings are precision engineered and precision made, quality controlled from raw material to finished ring.

36 functionally different types...as many as 97 different sizes within a type...5 metal specifications and 14 different finishes. Truarc rings are available from 90 stocking points throughout the U.S.A. and Canada.

More than 30 engineering-minded factory representatives and 700 field men are available to you on call. Send us your blueprints today...let our Truarc engineers help you solve design, assembly and production problems...without obligation.

For precision internal grooving and undercutting...Waldes Truarc Grooving Tool!

Send for new catalog supplement

WALDES TRUARC® RETAINING RINGS

Waldes Kohinoor, Inc., 47-16 Austel Place, L. I. C. 1, N. Y.
Please send the new supplement No. 1 which brings Truarc Catalog RR 9-52 up to date.
(Please print)

Name _____
Title _____
Company _____
Business Address _____
City _____ *Zone* _____ *State* _____

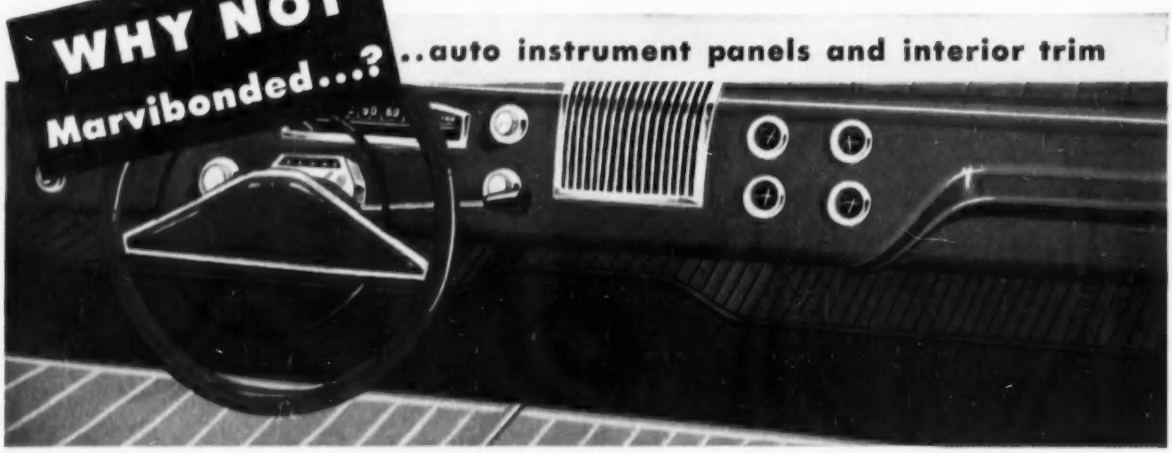
SA-127

WALDES TRUARC Retaining Rings, Grooving Tools, Pliers, Applicators and Dispensers are protected by one or more of the following U. S. Patents: 2,382,948; 2,411,426; 2,411,761; 2,416,852; 2,420,921; 2,428,341; 2,439,785; 2,441,846; 2,455,165; 2,483,379; 2,483,380; 2,483,383; 2,487,802; 2,487,803; 2,491,306; 2,491,310; 2,509,081; 2,544,631; 2,546,616; 2,547,263; 2,558,704; 2,574,034; 2,577,319; 2,595,787, and other U. S. Patents pending. Equal patent protection established in foreign countries.

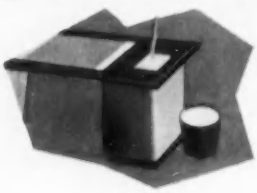
Here's Marvibond*
a new vinyl-to-metal laminating process that gives sheet metal products all these advantages...

- lasting protection against rust and corrosion
- practically any surface effect desired
- superior abrasion resistance
- outstanding resistance to perspiration and most chemicals
- uniform coverage of almost any thickness
- good sound-deadening properties
- less costly fabrication

WHY NOT Marvibonded...? ..auto instrument panels and interior trim

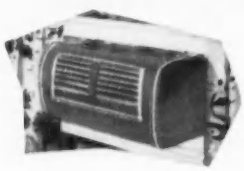


vending machine housings



waste baskets

business machine housings



air conditioner cabinets

Window moldings and dashboards of Marvibonded laminates could be permanently clad with vinyl material to match door upholstery and seat trim. And practically any choice of texture is possible–from glare-free matte finishes to rich leather-like grains.

There'd be no checking or flaking, no worries about scratched paint—no need for waxing or other care. The tough, chemical-resistant vinyl cleans with a wipe.

What's more, the vinyl surface would always be warm and pleasant to the touch. Marvibonding ends problems of rust from moisture condensation. And it helps to deaden sound, as well as insulate against squeaks from metal to metal contact.

Why not Marvibonded panels and trim! Plenty of excellent reasons *why*. Excellent reasons why for hundreds of similar applications—like radio and television housings, business machine covers, vending machines, air conditioners, waste baskets, and many many more.

Better see what Marvibond can mean to *your* product! Write the address below today.

*Pat. applied for

Naugatuck Chemical

Division of United States Rubber Company
Naugatuck, Connecticut

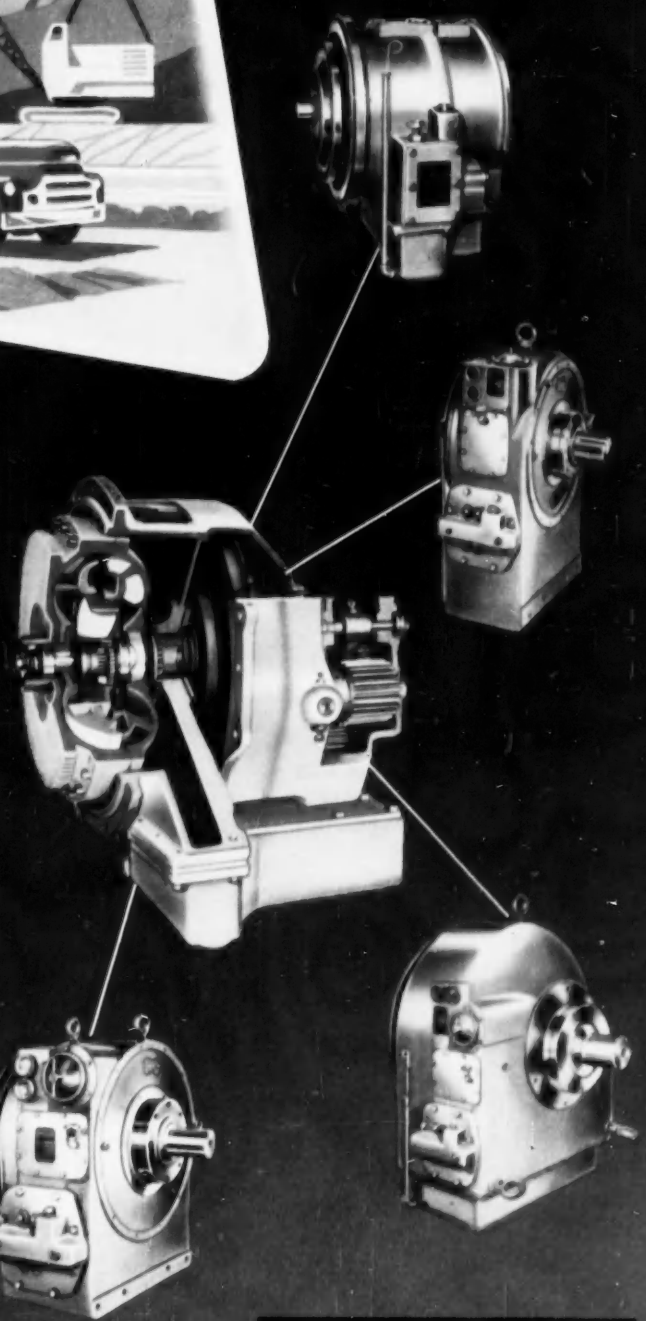
BRANCHES: Akron • Boston • Charlotte • Chicago • Los Angeles • Memphis • New York • Philadelphia • IN CANADA: Naugatuck Chemicals, Elmira, Ontario
Rubber Chemicals • Synthetic Rubber • Plastics • Agricultural Chemicals • Reclaimed Rubber • Latices • Cable Address: Rubexport, N.Y.

A TORCON Model to meet YOUR need

Two big advantages are yours, with a Torcon torque converter . . .

- this COMPLETE LINE, from 15 up to 600 hp, includes a model to fit your need
- Torcon's built-in oil pump and sump is a vital factor in dependable high efficiency.

You'll find the Torcon bulletin helpful.

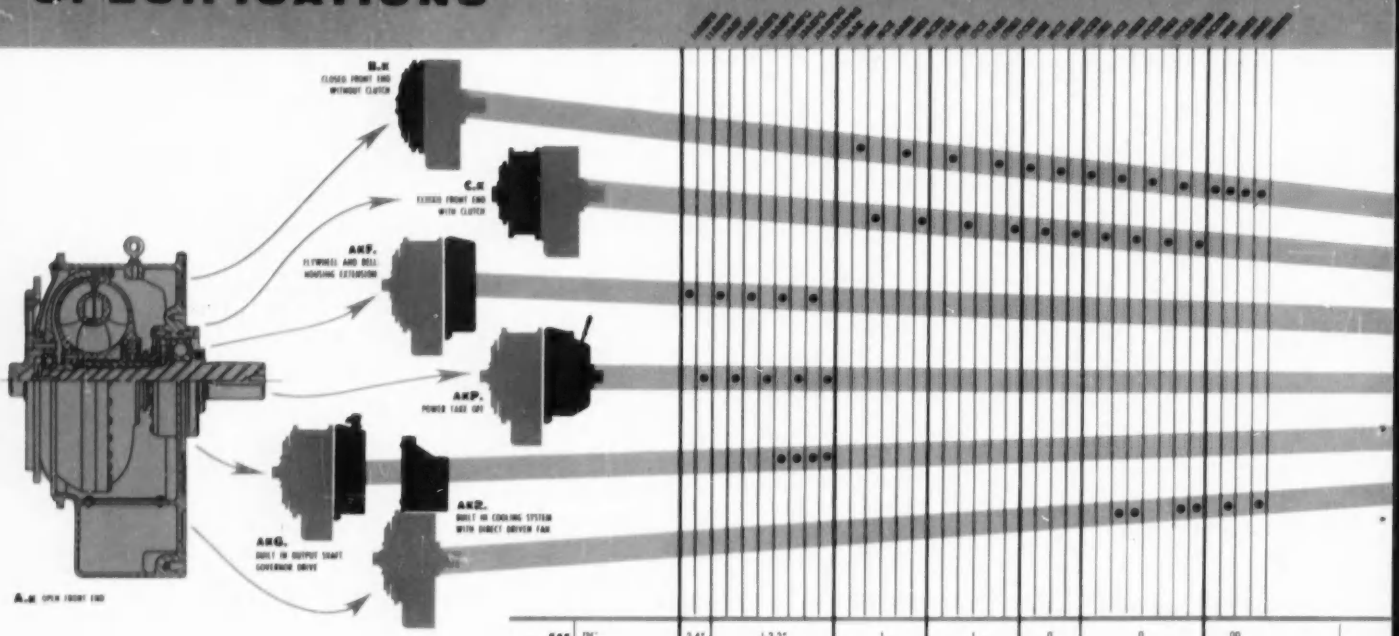


CLARK EQUIPMENT COMPANY • JACKSON • Buchanan, Battle Creek and Benton Harbor, Michigan

CLARK® EQUIPMENT

CLARK TORQUE CONVERTERS

SPECIFICATIONS



SAE HOUSING NUMBER								
IN	3.4"	1.2.3"	1	1	0	0	00	
OUT	4"	3" 4	PILOT FOR SAE #1 HSG.		PILOT FOR HSG. NOT SAE		PILOT FOR SAE #00 HSG.	

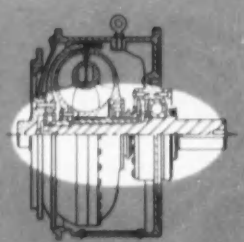
SCHNEIDER SYSTEM

NOTE:

All models are "K" series unless otherwise specified.

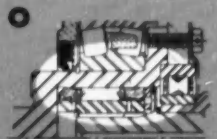
"K" series indicates built in oil pump and sump.

FIXED REACTION MEMBER UNLESS OTHERWISE SPECIFIED



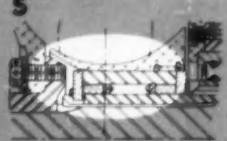
Open front. Fixed reaction member engine flywheel serves as pilot for converter or direct output shaft connection.

O



Over speed free wheel unit. This makes the engine friction h.p. available for braking. This provides positive mechanical connection from the output shaft to the input shaft whenever the output shaft is driving.

S



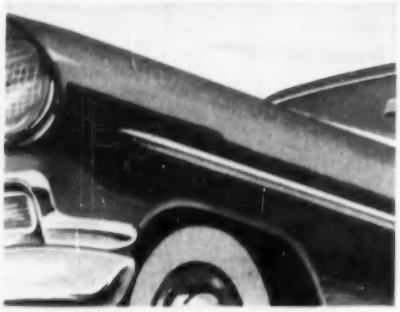
Double acting reaction member. The reaction member is mounted on sprag type free wheel unit. This permits the unit to function as a converter and hydraulic coupling.

TORCON

Transmission Division
CLARK EQUIPMENT COMPANY
Jackson, Michigan

CLARK® EQUIPMENT

A nut, washer
and sealing gasket
ALL IN ONE!



DAREX *Flowed-in* Gaskets

are streamlining traditional methods of attaching chrome trim to automobiles.

Contrasted with the laboriously slow method of hand assembling gasket to trim fastener, the DAREX method automatically *pre*-gaskets the part by machine. So that now a single fastener — applied in a single operation — *fastens* the trim and *seals* the hole against seepage of dirt and moisture.

The DAREX "Flowed-in" Process is ingeniously simple. A DAREX gasketing compound is *machine-flowed* directly onto the fastener. This "flowed-in" compound is then cured to form a solid, rubbery gasket which becomes *integral* with the part. With nut, washer and gasket all in one unit, automobile manufacturers find assembly-line fastening of chrome trim much easier and quicker. And the finished job is neater, better, less costly than before!

If you have a problem involving a gasket, cushion, seal or vibration dampener, tell us about it. Perhaps the DAREX "Flowed-in" Process can help you increase production or quality of your product . . . and at the same time lower your labor and materials costs.

"H637 COMPOUND"

One of several standard DAREX "Flowed-in" compounds now being used by the automotive industry.

Base: Vinyl

Adhesion to metal: Excellent, no primer coat needed

Torque retention: Excellent

Staining: No migration staining

Temperature resistance: -20° to 250°F.

Aging: Excellent

Consistency: (Wet) Non-slumping paste
(Dry) Rubbery solid

Curing time: 20 seconds

Uses: As a weather seal against water, dust and dirt

DESIGNED FOR THE AUTOMOTIVE INDUSTRY

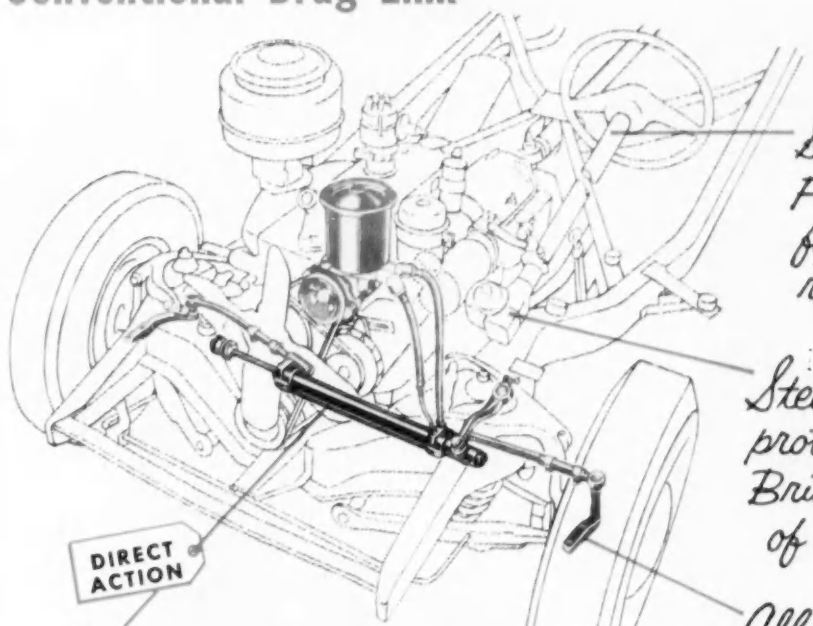
The new DAREX No. 6 Compound Applying and Curing Machine applies and cures gaskets automatically at high speeds (up to 200 per minute on trim fasteners shown above.) Occupies only 17 sq. ft. of floor space. Write for further information today.

{ Dewey and Almy does not make the fasteners shown above. We supply their manufacturers with gasketing compounds and machines to apply them. }

DEWEY and ALMY
Chemical Company
DIVISION OF W. R. GRACE & CO.
Cambridge 40, Massachusetts

MONROE DIRECT ACTION POWER STEERING

The only Truly Direct Action Design... Monroe Power Unit Replaces the Conventional Drag Link



Steering wheel Free from shock for safest, most restful driving

Steering gears protected against Brinelling action of road shocks

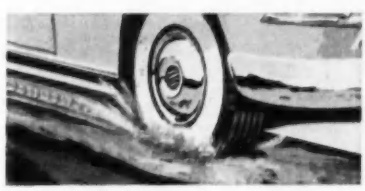
All road shocks pass into hydraulic power unit

Monroe Power unit is closest to wheel, for more direct action

Monroe is the only Direct Action Power Steering—as it is the only design where power unit replaces the drag link. Being Direct Action, and placed closest to the wheel, Monroe's hydraulic unit more completely absorbs road shock. Road shock can't reach the steering gears, so wear at this important point is reduced by as much as 70 to 80 percent. Brinelling is eliminated. No other system has so few parts, is so simple, or permits savings up to 20% by replacing the conventional drag link.

Our engineers will be glad to work with you on your Power Steering problems.

MONROE AUTO EQUIPMENT COMPANY, Monroe, Michigan

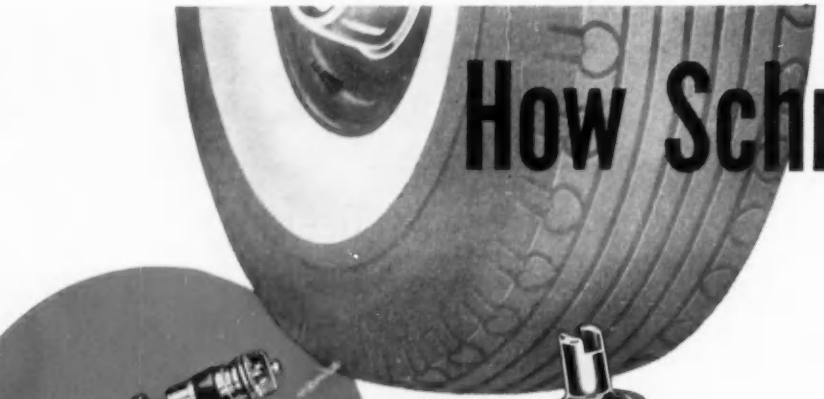


GREATER SAFETY—The firm, positive control of Monroe Direct Action Power Steering, eliminates much of the danger of dropping off pavement into soft shoulders, blowouts, flooded pavements, panic stops and such emergencies.

EFFORTLESS PARKING—Because Monroe Direct Action Power Steering takes practically all of the strain and effort out of parking, dealers find that sales of cars equipped with this device are much easier to make.

EASIER DRIVING—Monroe Direct Action Power Steering absorbs road shock before it reaches steering wheel. This, plus the removal of strain and effort of steering, leaves the driver fresh and relaxed after hours of driving.

How Schrader



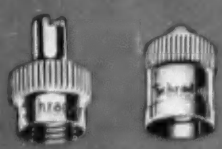
Schrader Valve Core gives extra protection—long core with stainless steel spring at bottom inflates easily—self cleaning seat. Positive seal means safety.

REPLACEABLE VALVE CORE SEALS AIR IN SIMPLIFIES INFLATION

Interchangeable in various standard valves

NEWEST TUBELESS TRUCK TIRE VALVES

Schrader TR 500 Series CLAMP-IN TRUCK TUBELESS TIRE VALVES—latest, most modern.



Schrader Caps seal valves for better tire performance—dirt and moisture can't get in—air can't get out. Special rubber washer reinforced with two brass plates assures perfect swivel-seal.

SEALED VALVES MEAN BETTER TIRE PERFORMANCE

Schrader gauging protects tires. Gauges for every use—from pocket gauge to master gauge, keep air lines "certified" accurate, tire properly inflated. Tires properly inflated deliver all the mileage built in.

GAUGING PROTECTS TIRES, INCREASES MILEAGE

Schrader®

ESTABLISHED IN 1844

helps protect your product at the customer level

Schrader Chuck Gauge—new unit with replaceable gauge cartridge simplifies inflating, deflating for dealer. Accurate air service keeps tires rolling better, safer.

INFLATING—DEFLATING SIMPLIFIED FOR DEALER

Schrader Service Tools make dealer valve service easy—whether on tubeless or conventional tires.

SIMPLIFIED TOOLS MAKE TIRE AND TUBE REPAIRS EASY

Schrader tire valve and air service products for dealer use promote tire safety, economy.

You make certain that mileage, safety, economy are built into your equipment tires. Through your dealers, through service stations, through garages—all over the world—your product is serviced. In order to do this job—the serviceman needs the right tools, the right replacement parts, the "how-to" information, to match the quality of your product. That's why Schrader, as the leading air products supplier to the Tire and Rim Industry works with the tire manufacturer in designing valves to meet the Industry's specific needs. And Schrader specializes in providing the tools, the parts, the information to dealers all over the world. These Schrader quality products are stocked and sold wherever your tire goes.

And more important—the world-wide service is possible because of the tire inflation principle developed by Schrader over 50 years ago—which still stands today! Every device, every Schrader Valve, Valve Core, Valve Cap is immediately, easily interchangeable anywhere in the world.

If you'd like to see the latest Schrader Air Products Service Manual—write for Manual A-100. A. Schrader's Son, Division of Scovill Manufacturing Company, Incorporated, 470 Vanderbilt Avenue, Brooklyn 38, N. Y.

FIRST NAME IN TIRE VALVES

FOR ORIGINAL EQUIPMENT AND REPLACEMENT

How Aluminum parts

For better parts at lower cost . . .

help Ford cut costs

THE Ford Motor Company recently changed its specifications on the Ford car windshield wiper knob insert to aluminum. This Ford part is one of several new screw machine parts now made from aluminum. They are currently studying other screw machine parts for possible conversion to aluminum.

This conversion met the requirements of management, design engineering and production groups.

Management requirement: Savings

Change to aluminum saved approximately 24.8%. Ford management is always interested in materials or methods that will effect savings with no sacrifice in quality. In this particular case, as in others, aluminum was selected because it provided savings of about 24.8% per piece, including scrap loss. Also, the aluminum parts are so much lighter than the previously used metal, that Ford has realized additional savings in shipping costs.

Designer requirement: Performance

Aluminum met design specifications. Ford engineers selected aluminum alloy 2011-T3, ⅜" round stock after they tested other metals and found that the aluminum knob insert would not only provide sufficient strength but would also take a slightly better knurl. The fact that aluminum satisfied performance requirements and for less money than other metals tested, was the main consideration in Ford's selection of aluminum.

Operator requirement: Machinability

Aluminum machined at maximum efficient cutting speed. The changeover to aluminum for this knob insert did not require any change in machining speed and setting from the previous metal used. Ford is running the part successfully at the maximum efficient speed of the automatic screw machine. And Ford found that it was not even necessary to change the angle of the form tool, which is an ordinary high speed steel tool with no chip-breaker.

The experience and engineering know-how of Ford has proved that properly designed aluminum parts can often provide substantial economies plus high quality.

You get these big advantages with aluminum

Each part costs less because you get *three times* as many parts from a pound of Kaiser Aluminum screw machine stock as you get from a pound of brass or steel. And these parts give you a unique combination of advantages, including lightness with strength, handsome finish, corrosion resistance, good heat and electrical conductivity.

Because of economy, plus these other advantages, we predict that hundreds of aluminum screw machine parts will soon become standard in American motor cars; for example, heater fan hubs, master brake cylinder pistons, door lock buttons, tire valves and spark plug terminals, compression fittings for gas and oil lines, hood release cable stops.

Our engineers will be glad to examine the screw machine parts now being used in your production to see how you can effect substantial savings by specifying them in Kaiser Aluminum.

Also, if you need assistance in finishing, welding, forging, roll-forming, extrusions, stampings, castings—or desire any type of engineering service and fabricating counsel—our development engineers will gladly provide it.

We may be able to suggest modifications in your designs, new fabrication techniques, changes in aluminum alloys—all of which may give you a better product at lower cost.

For immediate service, contact Kaiser Aluminum & Chemical Sales, Inc. *General Sales Office,* Palmolive Building, Chicago 11, Illinois. *Executive Office,* Kaiser Building, Oakland 12, California.

think of Kaiser Aluminum

Here's the secret of Micronic*-type Purolator's HIGH FLOW RATE

This little Purolator filter element can clean a quart of dirty lube oil in 60 seconds. It takes out sludge and solid impurities as small as one micron (.000039-inch) yet leaves beneficial additives unaffected. It operates with minimum pressure drop and a standard-size oil pump.

You can see the secret at the left. It's the Purolator Micronic element. This accordion-pleated, resin-impregnated element provides ten times the filtering area of older elements. This means faster filtration rates and far greater dirt storage capacity.

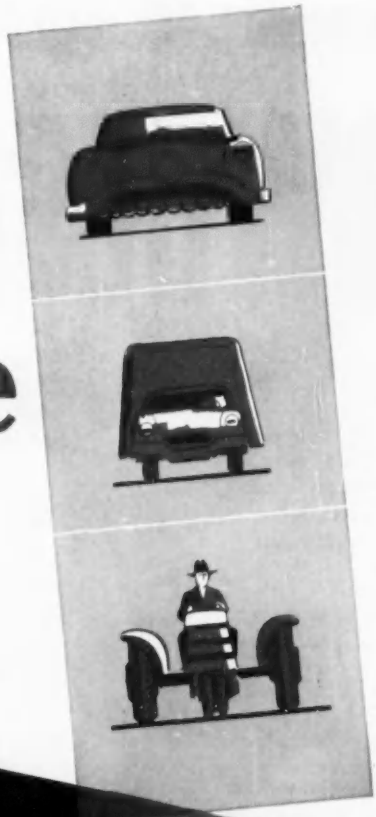
To designers and users of automotive equipment, Micronic-type Purolators offer thorough filtration by a small, compact unit that fits snugly into the lubricating system without needing an oversized pump to boost pressures through the filter. These advantages of Micronic filtration are among the many reasons why original automotive equipment manufacturers use more Purolators than any other type of filter.

Micronic elements do not channel. They are waterproof and warp-proof and remain unaffected by engine temperatures. There's a Purolator to fit every vehicle, tractor, and other gasoline- or diesel-engine-powered unit in service today. Write for our automotive catalog, No. 2054, to Purolator Products, Inc., Rahway, N. J., Dept. A3-1217.

*Registered Trade Mark

PUROLATOR

"FIRST IN THE FIELD OF FILTERING"



first choice

for modern cars, trucks and tractors

"No Kick-Out" feature combines new starting efficiency with proven economy

• Higher compression ratios, lighter flywheels and other advancements in modern engines have long pointed up the need of a starter drive that would follow through the weak explosions until the engine actually runs on its own power.

That's why vehicle manufacturers are turning in ever increasing numbers to the Bendix* Folo-Thru Drive as the solution to quicker and more dependable starting even under most adverse conditions.

This preference for the Bendix Folo-Thru Drive on modern vehicles is a most logical one, for Bendix Drives have always been the industry's choice as the most economical and efficient starting equipment.

*REG. U. S. PAT. OFF.

ECLIPSE MACHINE DIVISION of

Bendix
AVIATION CORPORATION

ELMIRA, NEW YORK

Export Sales: Bendix International Division, 205 East 42nd St., New York 17, N. Y.

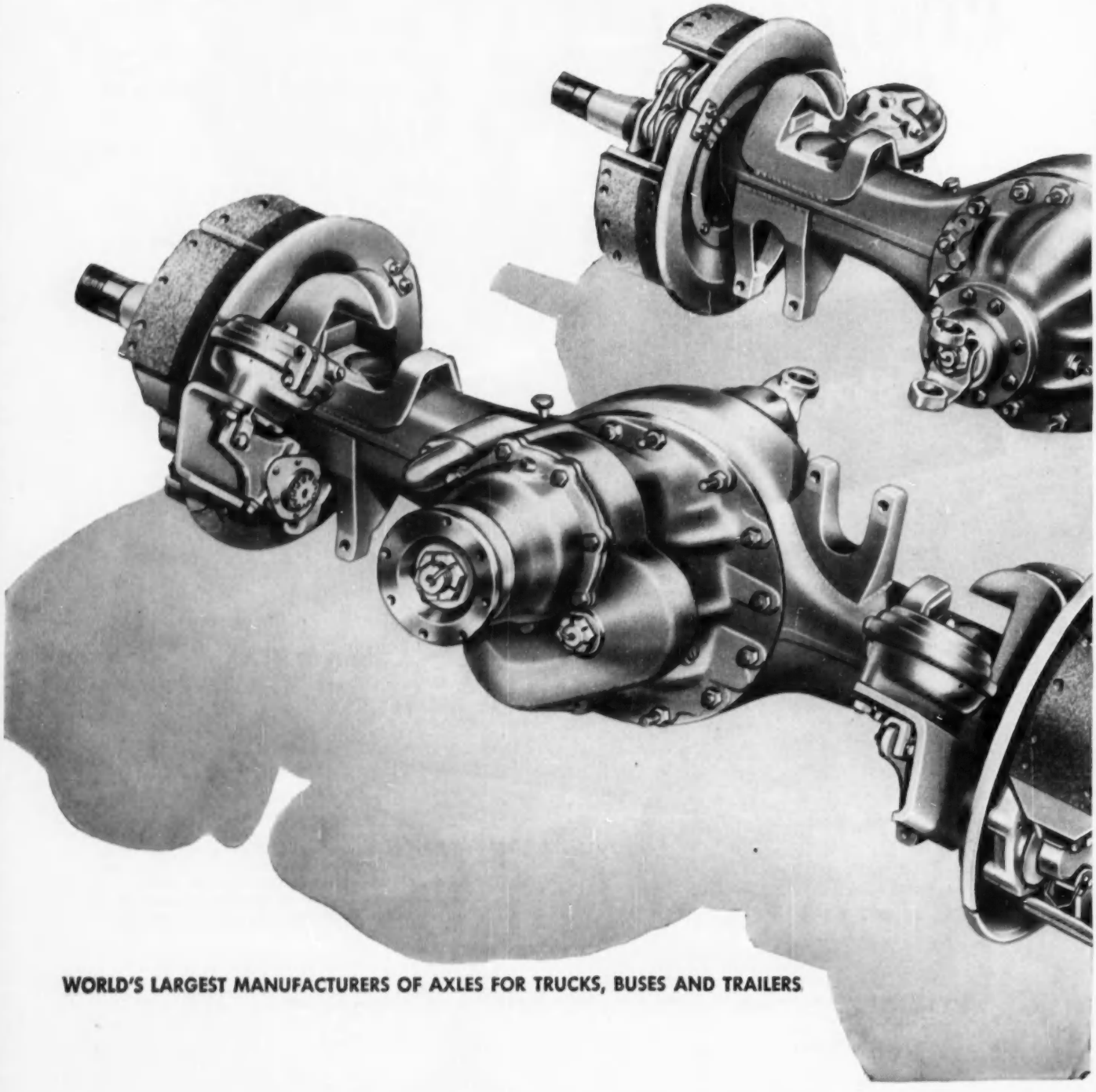
Bendix folo-thru starter drive

costs less. ***Like the more than 95,000,000 Bendix* Starter Drives manufactured for the industry, the new Folo-Thru Drive requires no actuating linkage and the solenoid may be placed in any convenient position. Result is lower installation costs and no adjustments. Complete detailed information is available on request.***

Bendix* Folo-Thru Starter Drive  Bendix* Automotive Electric Fuel Pump  Stromberg* Carburetor 

Now! A greater

SPECIALLY DESIGNED



WORLD'S LARGEST MANUFACTURERS OF AXLES FOR TRUCKS, BUSES AND TRAILERS

payload tandem

FOR HIGHWAY USE!

Lighter! The new Timken-Detroit lightweight tandem brings vital new opportunities for savings and profits to all highway truckers because of greater payload.

Serviceable! Built almost entirely from interchangeable companion parts used in famous Timken-Detroit single driving axles.

This lightweight tandem has all the features that contribute to profitable highway operation with all unnecessary bulk and weight eliminated. One Timken lightweight tandem unit is more than 200 pounds lighter than any other tandem unit of the same capacity!

Each year highway hauling achieves more spectacular importance. *Now* TDA presents a new lightweight tandem specially designed to answer the needs of over-the-road trucking. It is offered with a choice of either Timken-Detroit axle connecting groups, or brackets to accept other approved chassis hook-up parts. You get all these additional advantages with the Timken lightweight tandem:

Many proven standard parts and assemblies, gears, pinions, differentials, brakes used in Timken-Detroit *single axles* are incorporated in the new lightweight tandem. This assures operators fast, economical service with minimum down time.

A true inter-axle differential always under drivers' control is an important feature of the Timken-Detroit lightweight highway tandem.

Big, dependable hypoid gears rotate in conventional manner, carry load on normal drive side of teeth for increased gear and bearing life.

Torture-tested TDA axle shafts are upset forged and heat treated to insure top tensile strength.

Rugged hot-forged housings—pound for pound—are the strongest and most rigid built.

Less unsprung weight means lower impact and shock loads, for longer truck and trailer life.

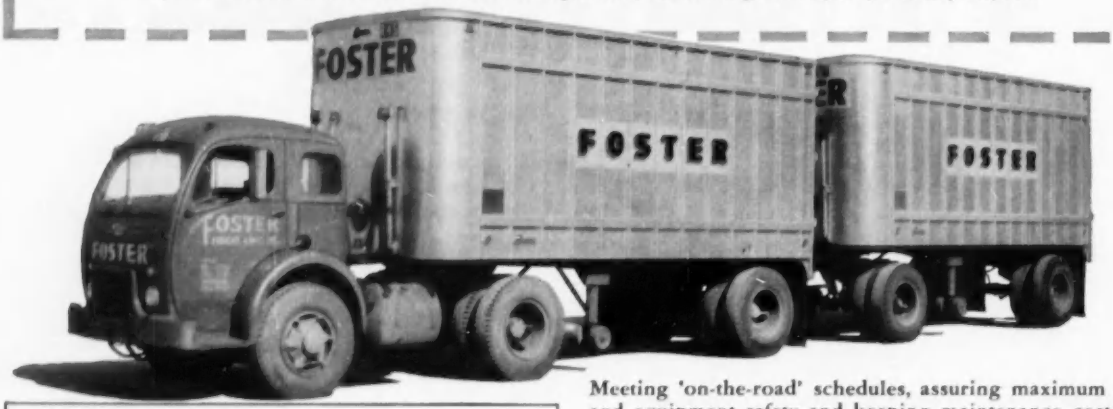
This new highway tandem insures new payload profits, faster, easier service and operating economies for highway truckers everywhere. For complete information contact your nearest vehicle dealer or branch.

Plants at: Detroit, Michigan • Oshkosh, Wisconsin • Utica, New York • Ashtabula, Kenton and Newark, Ohio • New Castle, Pennsylvania

"Wagner Air Brakes

...keep brake maintenance costs low because they are so dependable."

says: R. J. CUMMINS, Maintenance Control Supervisor, Foster Freight Lines, Inc., Indianapolis, Ind.



FOSTER FREIGHT LINES · INC.

General Office • 7240 South Holt Road • Indianapolis, Indiana

"Foster by Foster"

Wagner Electric Corporation
6400 Plymouth Avenue
Saint Louis 14, Missouri

Gentlemen:

"Foster by Foster" is the motto that keynotes the "One Handling Freight Service" we provide in Indiana, Ohio, Kentucky, Missouri and Illinois. Our customers can be assured 'on schedule' delivery of cargo because of our modern operation. This service policy carries through our whole set-up—from an automatic dragline in our terminal to the specifying of reliable, economical air brakes for our tractor and multiple trailer units.

Approximately 80% of our present power units are equipped with Wagner Air Brakes. In the years we've been using the Wagner Rotary Air Compressor, many of them have operated efficiently for unusually long periods of time without failure or need for repair. Wagner Air Brakes are quiet in operation, have fast air pressure recovery and keep brake maintenance costs low because they are so dependable.

We definitely plan to continue to order Wagner Air Brakes as original equipment.

Very truly yours,

R. J. Cummins
Maintenance Control Supervisor

Meeting 'on-the-road' schedules, assuring maximum cargo and equipment safety and keeping maintenance costs at a minimum are major responsibilities for all fleet operators. You can see from Mr. Cummins' letter how his company's operation benefits from the dependability of WAGNER AIR BRAKES.

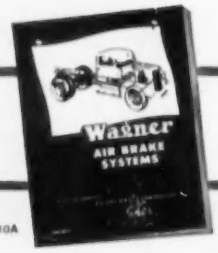
Actual checks with fleet operators have clearly shown that many units equipped with WAGNER AIR BRAKE SYSTEMS never have compressor failure or require compressor exchange—even after *years* of service. This high performance record is largely due to the superiority of the WAGNER ROTARY AIR COMPRESSOR. It is the *only* compressor utilizing *rotary motion* to keep friction loss low and operating efficiency high. Because of its fast air recovery, users are assured an adequate supply of air pressure at all times. This feature alone guarantees safe, sure stopping power to meet any road emergency.

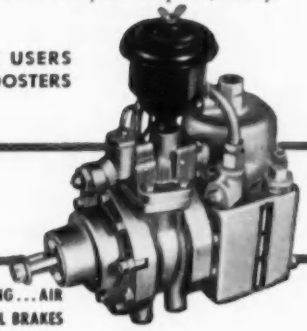
WAGNER ROTARY AIR COMPRESSORS eliminate carbon formation in air lines and reduce fire hazard. Uniform torque load provides smooth, quiet operation with moderate stresses. Parts are interchangeable and only a minimum of preventive maintenance is required.

Because of the ever-increasing demand for greater road and cargo safety and maintenance economy, it will pay you to include Wagner Air Brakes as standard equipment on the vehicles you manufacture.

Send for your free copy of Wagner Bulletin KU-201 for full information and complete details. It will be sent to you without cost or obligation. Mail your request, today.

WAGNER AIR BRAKE USERS ARE OUR BIGGEST BOOSTERS





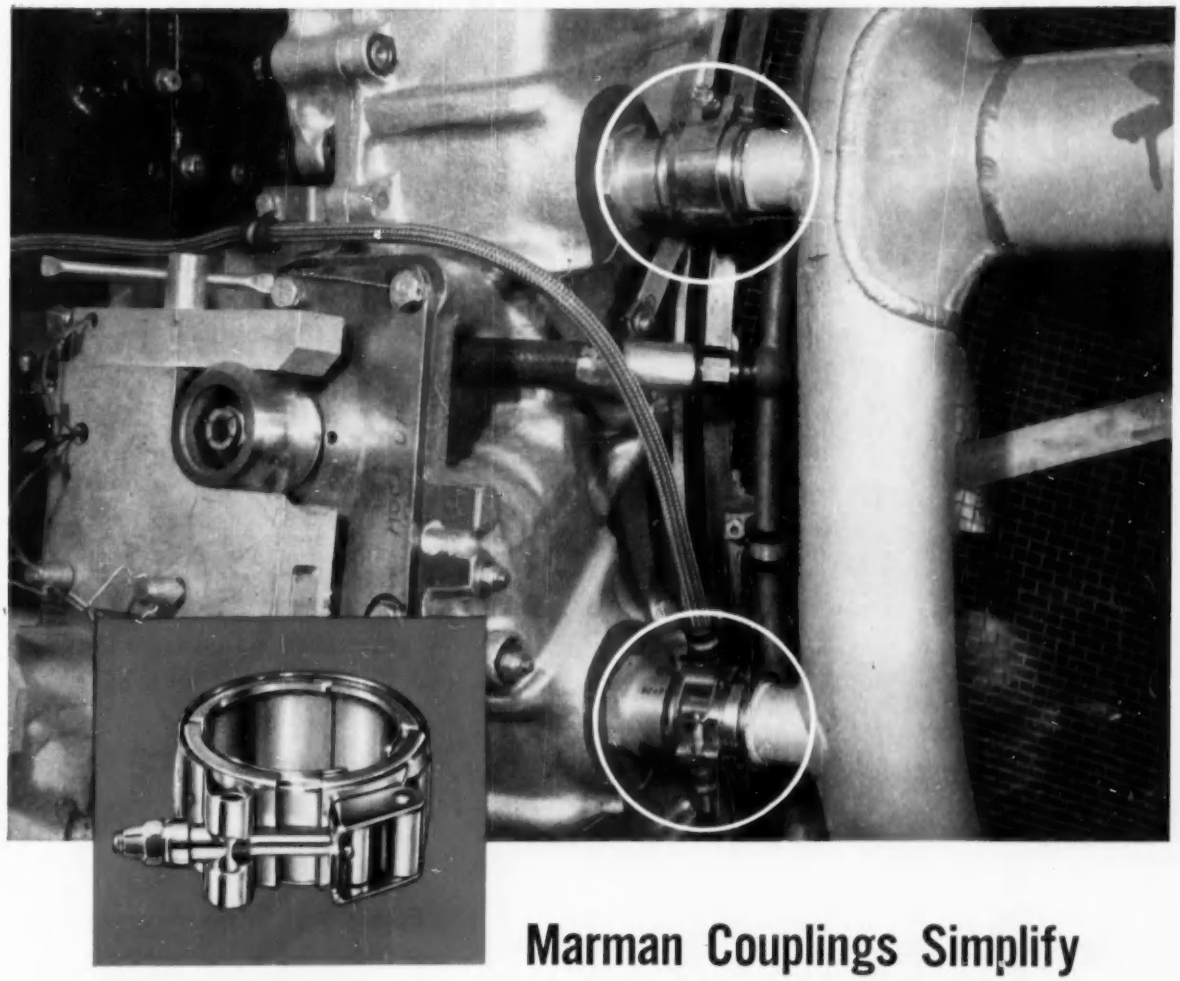
Wagner Electric Corporation

6378 PLYMOUTH AVENUE • ST. LOUIS 14, MO., U. S. A.

(Branches in Principal Cities in U. S. and in Canada)

LOCKHEED HYDRAULIC BRAKE PARTS and FLUID...NoRol...CoMoX BRAKE LINING...AIR BRAKES...TACHOGRAPHS...ELECTRIC MOTORS...TRANSFORMERS...INDUSTRIAL BRAKES

K55-10A



Marman Couplings Simplify Manifold Installation on Lockheed T2V1 Trainer

The advantages of Marman stainless steel clamps and couplings in simplifying engine and air frame installations are demonstrated on Lockheed's T2V1 jet trainer.

The picture above shows how Marman channel band couplings connect the aluminum manifold to the J33 engine. Installation time is greatly reduced. And, Marman V-band couplings and C15 hot air joints are used to couple the manifold to bleed off ducts.

Let the time-saving, money-saving advantages of Marman clamps, straps and couplings simplify your fastening and joining problems. Write today for full information.

MARMAN PRODUCTS COMPANY, INC.

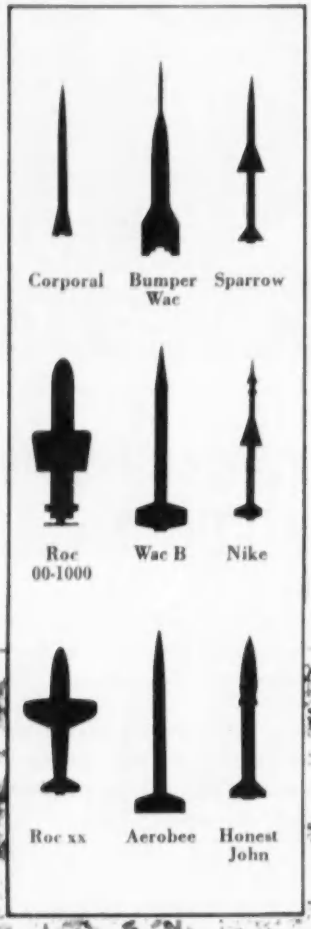
A SUBSIDIARY OF Aeroquip CORPORATION

11214 EXPOSITION BLVD., LOS ANGELES, CALIFORNIA

MARMAN PRODUCTS ARE MANUFACTURED UNDER VARIOUS U.S. AND FOREIGN PATENTS AND OTHER PATENTS PENDING

Douglas announces...

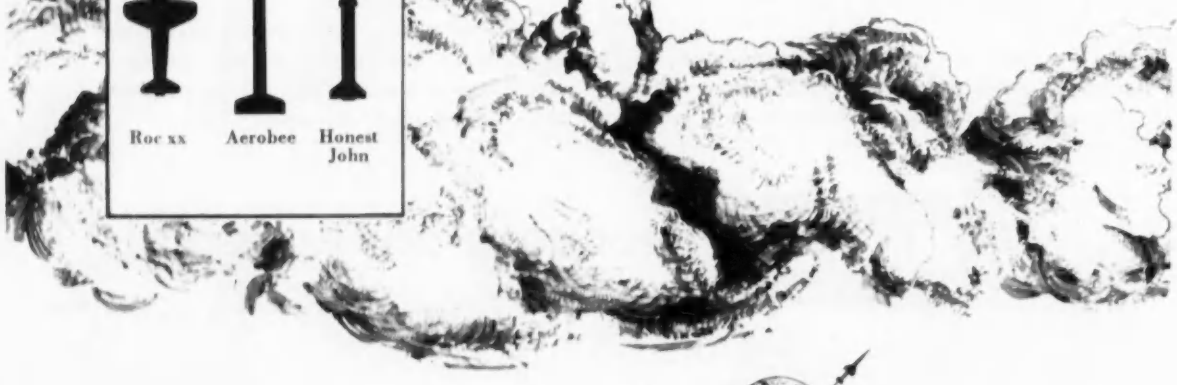
the formation of a separate Missiles Engineering Department



Growing importance of missiles in the nation's defense has led to the separation of missiles engineering from aircraft engineering functions at Douglas Aircraft Company.

Leadership in this important field has been won by Douglas in 14 years of development and design of guided missiles for the Armed Forces. Douglas is currently engaged in eight major missiles projects, under contracts from the Air Force, Army and Navy.

Formation of the new department at Douglas opens new opportunities for engineers and scientists interested in the missiles field. Write to: E. C. Kaliher, Engineering Personnel Manager, Missiles, Douglas Aircraft Co., Santa Monica, California.



Missiles by *DOUGLAS* **First in Aviation**

Styling unlimited!

WITH ALUMINUM "JEWELRY" AT BASE METAL PRICES

By the magic of anodized finish, aluminum may be given the gleam of precious metals, the luster of brushed satin, or brilliant built-in color. Its surface can be textured in a multitude of patterns.

Yet this metal of a thousand faces is an extremely *practical* metal. It can be cast, stamped, drawn, extruded, forged. Easily formed, machined and buffed, it costs less per finished part in many cases than parts of stainless steel or chrome.

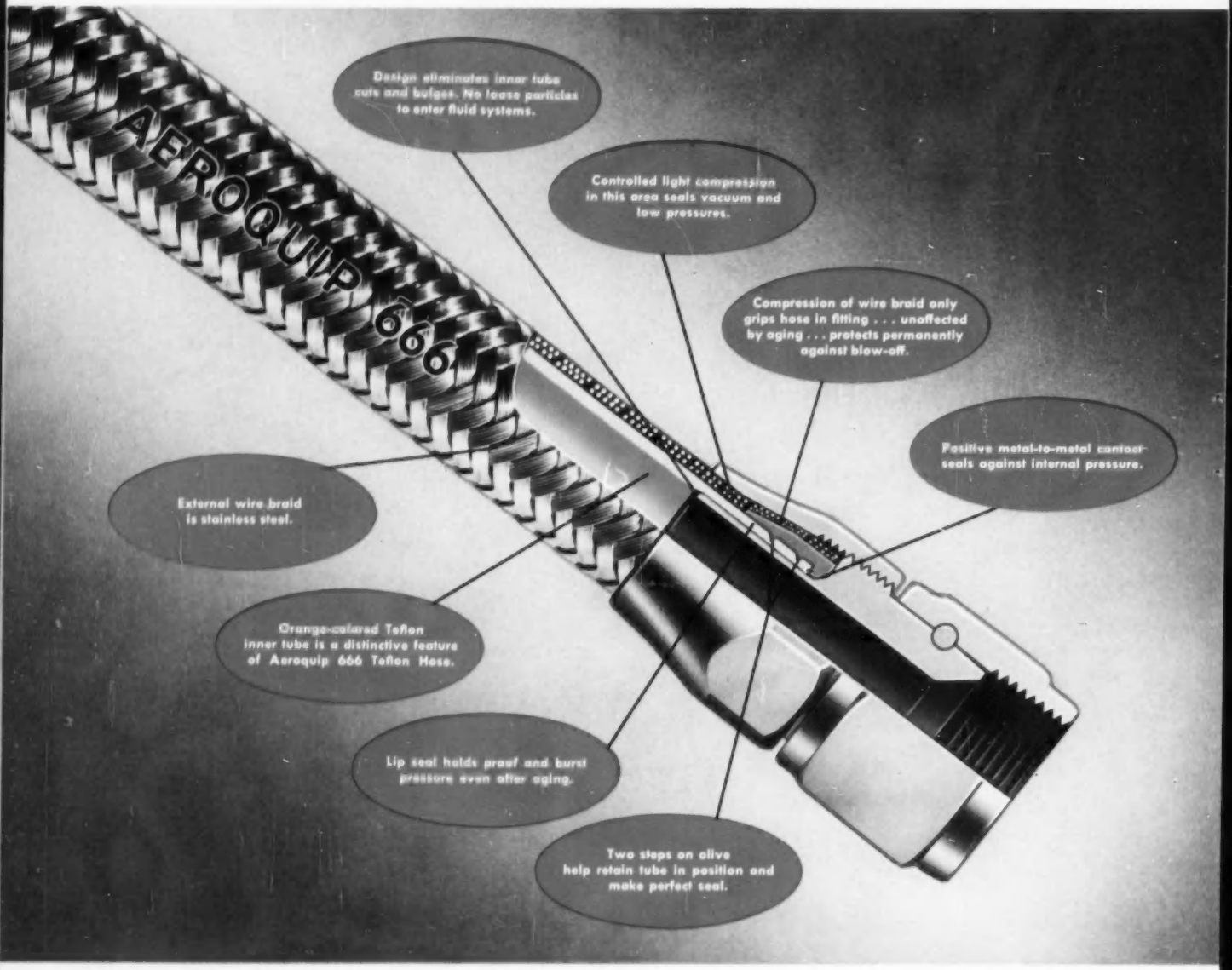
Alcoa does not make automotive trim. We *do* offer you unequaled technical guidance in fabricating and finishing aluminum. To make use of this service, contact the nearest Alcoa sales office. For useful design data, write for our new, free 48-page brochure, *Finishes for Alcoa Aluminum*. Address: Aluminum Company of America, 1844-M Alcoa Building, Pittsburgh 19, Pa.

- Dashboard in textured and patterned sheet with built-in color
- Scuff and kick plates in sparkling patterned sheet
- Instrument knobs and door handles in finely textured satin, natural or colored finish
- Moldings in gleaming mirror finish
- Instrument panel trim in gleaming colors and patterns

Your Guide to Aluminum Value

WE CHOOSE ALCOA ALUMINUM MILL PRODUCTS

Years Ahead! Detachable,



"super gem" is an Aeroquip trademark

Aeroquip

REG. TRADEMARK

AEROQUIP CORPORATION, JACKSON, MICHIGAN
AERO-COUPLING CORPORATION, BURBANK, CALIFORNIA
AEROQUIP (CANADA) LTD., TORONTO, ONTARIO, CANADA

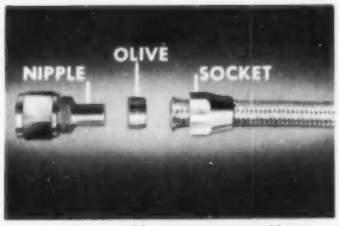
LOCAL REPRESENTATIVES IN PRINCIPAL CITIES IN U.S.A. AND ABROAD • AEROQUIP PRODUCTS ARE FULLY PROTECTED BY PATENTS IN U.S.A. AND ABROAD

Leakproof "*super gem*" Fittings

(PATENT APPLIED FOR)

and 666 Teflon* Hose

ASSEMBLE QUICKLY, EASILY WITH ORDINARY BENCH TOOLS!



Aeroquip's new "*super gem*" Fitting consists of nipple, olive, and socket. First step in assembly is to slide socket over the hose.

Next, the olive is pushed by hand into position between the Teflon inner tube and the wire braid.

Assembly is completed by screwing the nipple into the socket using an ordinary AN adapter.

"*super gem*" FITTINGS WILL NOT LEAK EVEN AFTER HIGH TEMPERATURE AGING. Unlike conventional swaged or crimped fittings, the "*super gem*" Fitting does not hold the hose by compression of the Teflon inner tube. There can be no loss of compression due to the cold flow characteristics of Teflon with resultant leakage at proof pressures.

"*super gem*" FITTINGS SAVE WEIGHT. Available in steel, stainless steel, or aluminum, "*super gem*" Fittings offer significant weight savings . . . particularly in the larger sizes.

ELIMINATE EXPENSIVE, HEAVY ASSEMBLY OR SWAGING MACHINES. A vise and a wrench are the only tools needed to assemble 666 hose and "*super gem*" Fittings.

SIMPLIFY ENGINEERING MOCK-UPS AND PRODUCTION CHANGES. Development and production engineers have complete freedom in making changes, even on the production line. New hose lines can be made in minutes. Scrap costs are kept to a minimum because end fittings on assemblies can be reused and hose salvaged.

REPLACE HOSE LINES QUICKLY IN THE FIELD. Simple assembly of 666 hose and "*super gem*" Fittings makes field replacement easy. Minimum inventories of bulk hose and fittings are required for field storage.

666 TEFLON HOSE IS DESIGNED TO AEROQUIP'S EXACTING SPECIFICATIONS. Distinctive orange-colored inner tube provides positive identification. Operating temperatures are —100° F. to +500° F. Sizes and pressure ranges are suited to all engine and airframe fluid systems.

*Du Pont Trademark for its tetrafluoroethelene resin

Aeroquip Bulletin AEB-9 Gives Complete Technical Information and Test Data

Fill in and mail the handy coupon on the next page

Aeroquip

REG. TRADEMARK

ADJUSTABLE ELBOW FITTINGS Simplify Hose Line Installation

Aeroquip *"super gem"* Adjustable Elbow Fittings can be loosened and rotated to the exact position required as the hose assembly is installed. They are then tightened in position. This adjustment has absolutely no effect on the grip of the fitting on the hose. There is no danger of hose twist. Ordering is simplified.

Aeroquip Corporation,
Jackson, Michigan

Gentlemen:
Please send me your Bulletin AEB-9 on reusable *"super gem"* Fittings and 666 Teflon Hose.

Name _____

Title _____

Company _____

Address _____

City _____ **Zone** _____ **State** _____

FILL IN AND MAIL THIS COUPON TODAY FOR AEROQUIP BULLETIN AEB-9

Get complete technical information and test data on Aeroquip 666 Hose and *"super gem"* Fittings!

Lockheed diversification in action...

At right: engineers and scientists work on some of the 46 major projects in progress at Lockheed

Operations Research discussion on continental defense

Operations Research openings

Electronics Specialists
Fire Control and Guidance Specialists
Aerodynamics Engineers
Physicists

Fatigue test on Super Constellation skin

Structural Engineering openings

Research Specialists
Structures Engineers
Stress Analysts
Weight Engineers

Why Lockheed offers Engineers better careers

There are three main reasons:

1. More opportunity for promotion
because there are more supervisory positions to be filled with 46 major projects underway, including 13 models of aircraft on assembly lines.

2. More career security
because Lockheed activities cover virtually the entire spectrum of aeronautical endeavor.

3. Life in Southern California
Scenic beauty, unmatched climate, wide recreational opportunities enhance life in the San Fernando Valley.

To Engineers who lack aircraft experience
Aircraft experience is not necessary to join Lockheed. It's your engineering training and experience that count. Lockheed trains you for aircraft engineering—at full pay.

Coupon below is for your convenience in requesting application form and more information on how Lockheed's expanding program can advance your career.

Design study on hydraulic requirements of new transport

Design openings

Design positions are open at all levels in controls, electrical, hydraulics, mechanical, power plant and structures fields.

IBM 701 applied to jet transport flutter problem

Math. Analysis openings

Math. Engineers
Math. Specialists
Math. Analysts

In-flight test on air speed performance

Flight Test Engineering openings

Flight Test Engineers
Flight Test Analysts
Instrumentation Engineers
Electrical Research Engineers

Aerodynamic meeting on high-speed fighter

Aerodynamics openings

Aerodynamics Engineers
Aerodynamicists
Dynamics Engineers
Wind Tunnel Test Engineers

E. W. Des Lauriers, Dept. C-16-12
LOCKHEED AIRCRAFT CORPORATION
CALIFORNIA DIVISION • BURBANK, CALIFORNIA

Please send me a brochure describing life and work at Lockheed and an application form.

Name _____

Field of Engineering _____

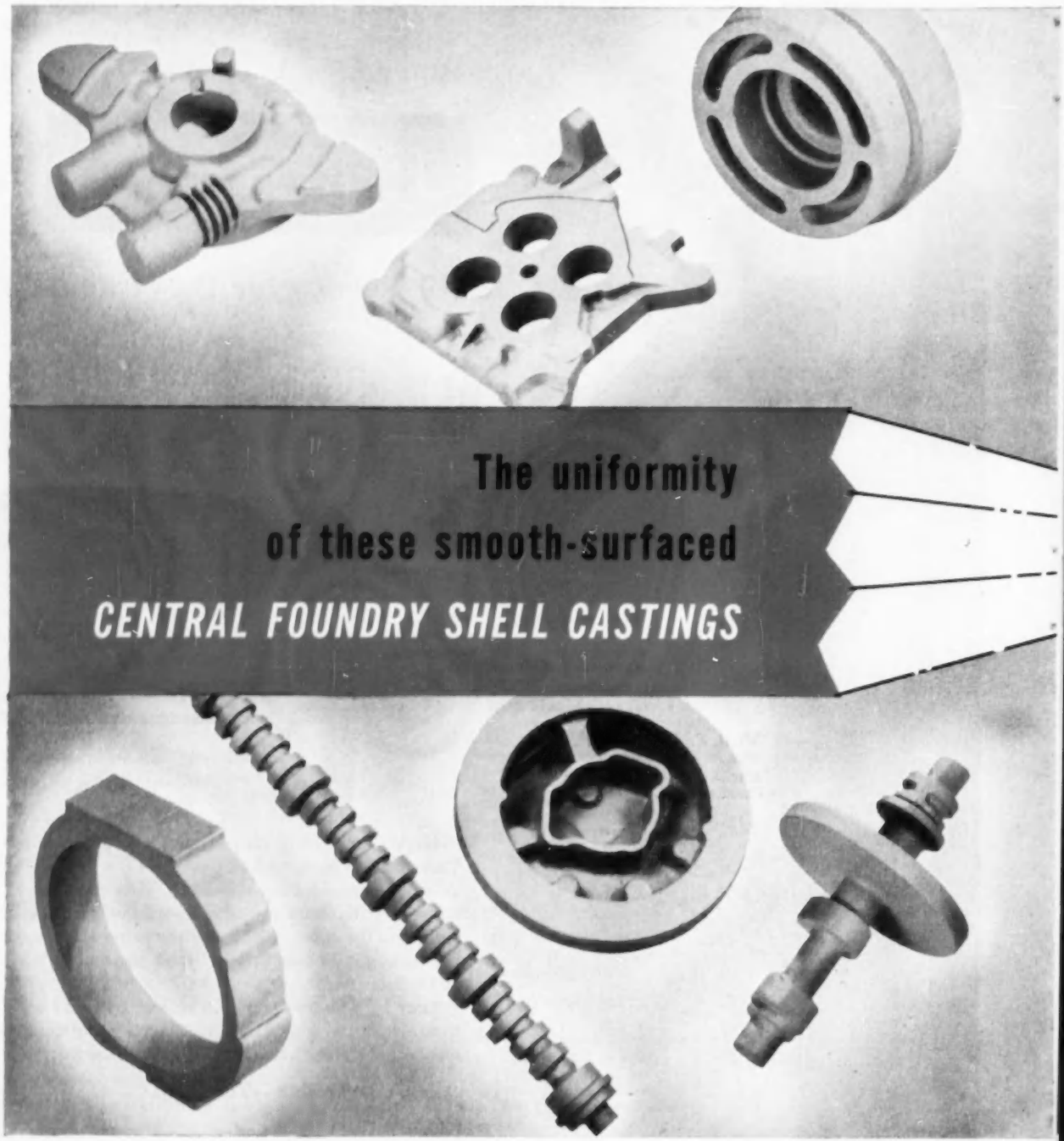
Street Address _____

Home Phone _____

City and State _____

LOCKHEED
California Division
AIRCRAFT CORPORATION
BURBANK **CALIFORNIA**

City and State



In shell casting, the mold is formed by a thin shell of sand bonded by a thermo-setting plastic. This shell has a hard, smooth surface as accurate as the pattern itself. Shell casting has many advantages • complicated cast contours (impossible with the green sand process) are practical • uniformity with reduced finish allowances permits lower machining cost and longer tool life • improved casting surfaces, free from residual sand, often eliminate machining on non-functional areas and • lower casting weights effect savings in freight charges.

For further information about shell casting grey iron, malleable iron or Armasteel and how it may improve or effect economies in your product, write for descriptive literature . . . or request personal help from our experienced engineers, without obligation.

makes it possible to greatly

reduce machine cycle time

on these *FINISHED PARTS*

CENTRAL FOUNDRY DIVISION

GENERAL MOTORS CORPORATION

SAGINAW, MICHIGAN • DEPT. 18

The Ideal Gift

for the Woman Who Has Everything . . .

Give Her Smoother Stopping,

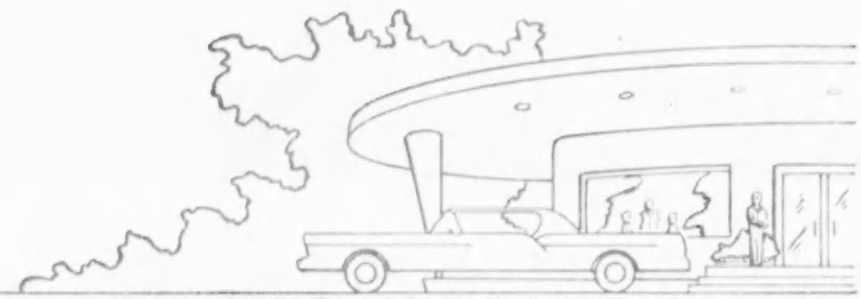
Safer Double-Disc Brakes

You can do it too. You're important to the automotive industry. You know from first hand experience or from reports that Auto Specialties Double-Disc Brakes have proven themselves superior to other brakes. You know that in a recent brake test in the mountains, conventional brakes failed after one trip down the mountain. Auto Specialties Double-Disc Brakes over the same course and under the same conditions still had braking power left after three trips. In other fade tests, foot pedal pressure necessary to stop shoe-and-drum brakes increased from 68 pounds at the first stop to 180 pounds at the twelfth stop. Double-Disc Brakes made twenty-two consecutive stops while maintaining a constant foot pedal pressure of 60 pounds. You know that Auto Specialties Double-Disc Brakes have also proven themselves superior in many other ways.

These are all things you probably know. But perhaps, what you don't know is that the manufacturer of Double-Disc Brakes, Auto Specialties Mfg. Co., Inc., Saint Joseph, Michigan, has received thousands and thousands of individual requests for these brakes. These requests alone would eat up a lot of automobile production. These requests for Double-Disc Brakes show that women are more safety conscious than men. Women are more vitally concerned with the lives of their children while driving. They want better brakes, safer brakes. Brakes that will give them more confidence while driving.

In a tough selling situation, Double-Disc Brakes can make the big sales difference. Thousands of requests for these brakes have poured into dealerships in New York, Detroit, Chicago and Los Angeles. The great promotional effort today is on safety. Safer Double-Disc Brakes will make cars easier to sell. You can do much to see that Double-Disc Brakes are adopted.

If you would like more information about these brakes, write to Auto Specialties Mfg. Co., Inc., Saint Joseph, Michigan.

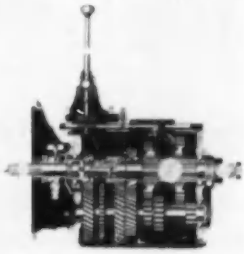


AUTO SPECIALTIES MFG. CO., INC.

SAINT JOSEPH, MICHIGAN

Plants also at Benton Harbor and Hartford, Michigan and Windsor, Ontario, Canada
Manufacturing for the automotive and farm machinery industries since 1908

YELLOW TRANSIT adds 200 new Fuller Transmissions



Model 5-A-65 Transmission

Yellow Transit Freight Lines, Inc. of Kansas City, Missouri, recently purchased 200 new cab-beside Kenworth Tractors for their 8,435 miles of certified routes through 8 midwestern states.

Powered by 175 hp turbo-supercharged diesel engines, these tractors are equipped with Fuller 5-A-65 heavy-duty 5-speed Transmissions. These Fuller "direct in fifth" Transmissions with constant mesh helical gearing in the top three speeds, were chosen because of their excellent performance for Yellow Transit in the past.

Says William R. Riley, Yellow Transit's Superintendent of Maintenance: "We have used Fuller Transmissions for a number of years. Our satisfactory experience guided us in the selection of these transmissions for the new Kenworths."

Fuller Transmissions let the driver select the ratio he needs at the *right* time to meet every varying condition of time, traffic and terrain. See *your* local truck dealer today. Ask him for the most efficient, easiest-shifting Fuller Transmission to meet your trucking requirements.

Fuller TRANSMISSIONS

FULLER MANUFACTURING COMPANY (Transmission Division), KALAMAZOO, MICHIGAN

Unit Drop Forge Div., Milwaukee 1, Wis. • Shuler Axle Co., Louisville, Ky. (Subsidiary) • Sales & Service, All Products, West. Dist. Branch, Oakland 6, Cal. and Southwest Dist. Office, Tulsa 3, Okla.

Passenger Model Mercedes cars have adopted nickel cast iron brake drum liners because of the notable successes of Mercedes-Benz "Silver Arrow" racing cars so equipped in rigorous trials such as the Le Mans 24-Hour Road Race.

Nickel cast iron lines brakes of new 240 hp Mercedes 300 SL series cars

THIS RADIALLY FINNED brake drum for the new Mercedes model 300 SL embodies an Al-Fin bonded friction liner of nickel cast iron.

Fortified with nickel, the liner not only resists uneven wear from thermally induced stresses, but it also dissipates intense frictional heat from internal surfaces through the aluminum to the air, thus preventing "brake fade." In addition, it resists warpage.

And particularly important, in spite of irregular but rigorous cycles of heating and cooling, it resists heat-checking.

Life expectancy of cast iron parts can be materially increased by adding suitable amounts of nickel to properly adjusted base mixtures. In this way you improve structure, mechanical strength, thermal expansion characteristics and stability at elevated temperatures.

Nickel alloys have answered exacting demands throughout the automotive and allied industries. Whatever your metal difficulty, let us give you the benefit of our wide practical experience in this field.

Write for List A of available publications. It includes a simple form that makes it easy for you to outline your problem.

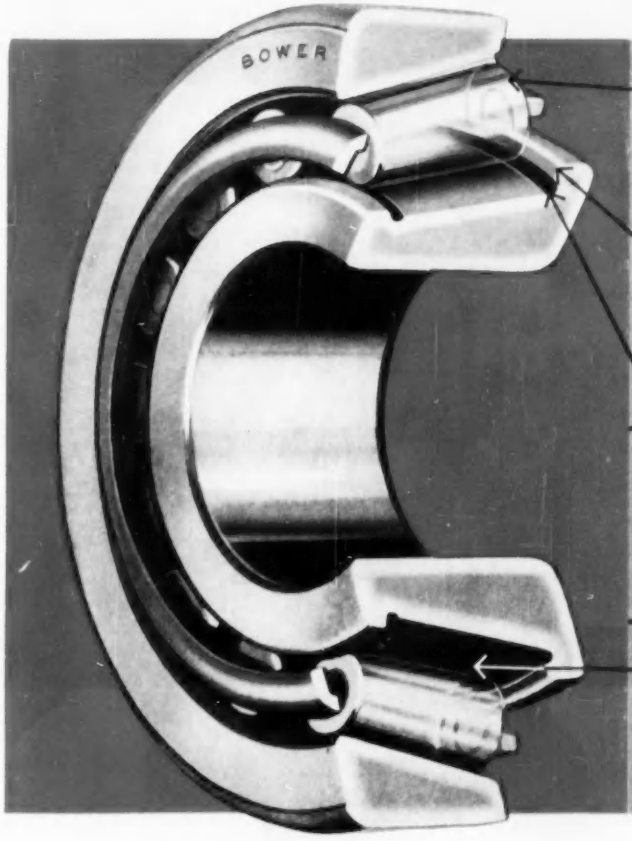
The friction liner of this Mark II type radially finned brake drum contains 0.80-1.00% nickel along with molybdenum and chromium. Ferrous liners are bonded into the cast aluminum drums by the Al-Fin process, a development of the Al-Fin Div., Fairchild Engine and Airplane Corp., Deer Park, N. Y.

INCO **THE INTERNATIONAL NICKEL COMPANY, INC.** 67 Wall Street New York 5, N.Y.

Here's how BOWER Spher-o-honed design lengthens bearing life... cuts maintenance costs!

The Bower tapered roller bearing design features shown on this page are vitally important to every bearing user. For they illustrate the high quality, precision workmanship and close attention to engineering detail that go into *every* Bower bearing. Even more important, these Bower design features will give you significant bearing advantages such as reduced wear, longer bearing life and lower maintenance requirements. They've been thoroughly *proved* by extensive use in virtually every type of bearing application. If your product uses bearings—whatever it may be—specify Bower now. Or better yet, call in a Bower engineer while your product is still in the blueprint stage.

BOWER ROLLER BEARING DIVISION
FEDERAL-MOGUL-BOWER BEARINGS, INC., DETROIT 14, MICH.



● **SPHERICAL ROLLER HEADS ARE GENERATED TO THE CONTOUR THEY ACQUIRE IN THE COURSE OF WEAR.** This helps Bower bearings hold adjustment and pre-load longer and better. Normal running-in time is virtually eliminated.

● **HIGHER FLANGE PROVIDES A LARGE, TWO-ZONE CONTACT FOR ROLLER HEADS,** thereby reducing unit pressure. This exclusive Bower feature improves roller alignment, greatly reduces wear and practically eliminates resultant "end play."

● **LARGER OIL GROOVE GIVES POSITIVE LUBRICATION** at the critical point—where the roller head thrusts itself against the cone flange. Here Bower design provides a larger recess that holds a generous supply of lubricant—increasing efficiency and decreasing wear.

● **PRECISION RACES PROVIDE QUIETER, SMOOTHER OPERATION.** A Bower-developed grinding and honing process provides a micro-smooth surface of hard, crystalline base metal. In this way, close-tolerance precision is built-in to stay! No final adjustment is needed!

A COMPLETE LINE OF TAPERED, STRAIGHT AND JOURNAL ROLLER BEARINGS FOR EVERY FIELD OF TRANSPORTATION AND INDUSTRY

BOWER
ROLLER BEARINGS

SPHER-O-HONED

From a dream-world marriage of mathematics and electronics...tomorrow's oil seals today

Looks simple, doesn't it—the oil seal pictured here. Actually, it's a precision assembly of high tolerance parts, each the product of painstaking engineering.

One such part is the unseen but vital tension spring behind the sealing lip. Thousands of these springs—all different—are needed in the broad line of National Oil Seals. Each spring must have exactly the size, coil diameter, tension, spring rate, and heat treat required for the oil seal it fits.

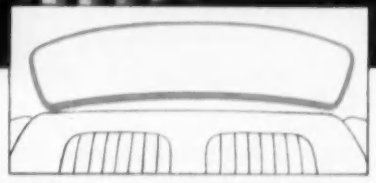
Done the conventional way, calculations of characteristics for thousands of springs would take months. So, National Oil Seal Engineers developed new mathematical methods which, in combination with Univac, permit specifications to be determined at speeds up to 150 per minute.

This fortunate marriage of mathematics and electronics is another example of efficient, "future" National Oil Seal engineering—and another reason why National consistently brings you tomorrow's oil seals today.

NATIONAL
OIL & GREASE SEALS
O-RINGS SHIMS

New Sealing Lip Design. Recent development of NMB Engineering is new lip design. New features include long, thin lip section and small coil diameter tension-spring. Contact on shaft is light, yet effective sealing is maintained throughout long service life.

NATIONAL MOTOR BEARING CO., INC.
General Offices: Redwood City, California
Plants: Redwood City, California and Van Wert, Ohio



Dodge selects Enjay Butyl rubber for big rear-window weatherstrip

Super-durable Enjay Butyl fits perfectly Dodge's rigid specifications for its rear-window weatherstrip. Under the toughest conditions of weather and use, Enjay Butyl parts stay like new, help add style and color to new cars. In fact, some automobiles have more than 100 parts made of this fabulous rubber.

The many advantages of Enjay Butyl make it the almost perfect rubber for the automotive industry. Its price and ready availability are advantages, too. And it is now available in non-staining grades for *white* and *light-colored* parts. For full information and for skilled technical assistance in the uses of Enjay Butyl, contact the Enjay Company at either of the addresses below.

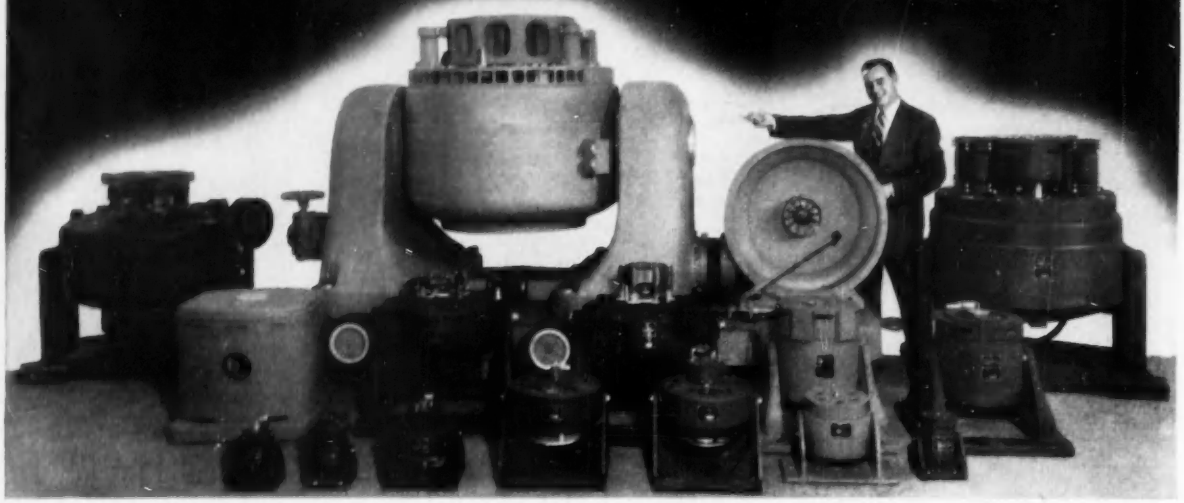
ENJAY BUTYL

Enjay Butyl is the super-durable rubber with *outstanding* resistance to aging • abrasion • tear • chipping • cracking • ozone and corona • chemicals • gases • heat • cold • sunlight • moisture.

ENJAY **ENJAY COMPANY, INC.,** 15 West 51st Street, New York 19, N. Y.
District Office: 11 South Portage Path, Akron 3, Ohio.

35 SUCCESSFUL YEARS OF LEADERSHIP IN SERVING INDUSTRY

Look at this progress in vibration exciters



A whole range of MB Shakers developed to handle any vibration testing program . . . deliver reliable, quantitative data

One pound to over twelve thousand pounds . . . that's the range of force outputs in this group of MB electrodynamic vibration exciters. On the way are shakers for 25,000, 50,000 and even 100,000 pounds! All operate over substantial frequency range. What a far cry from the limited scope of mechanical shakers . . . the only type available just a short ten years ago.

But force and frequency range are not the only improvements. MB has long recognized the need for *pure* table motion if test results were to be quantitative and reliable.

Thus, in MB Shakers, moving-element structures are very rigid. This minimizes table motion distortion in the testing range. Also, because MB power supplies are designed for negligible harmonic distortion, table waveform is pure over the whole frequency range.

There's more. MB has designed complex wave testing systems that shorten test time and give truer reproduction of actual service conditions. Also oil-filled exciters capable of operation at "100,000 ft. altitude," —100 to +200°F, and 20 to 95% relative humidities. Also cycling systems that do time-consuming test procedures *automatically*.

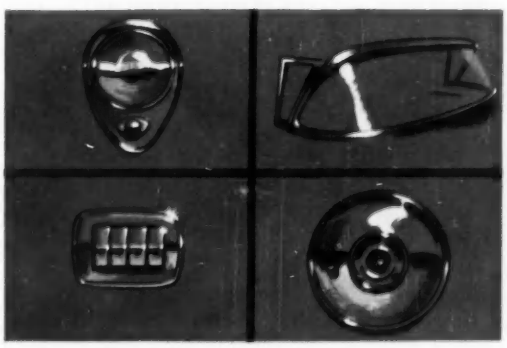
If you're working on projects that call for environmental testing, or fatigue testing, or noise determinations . . . you can benefit from vibration testing with MB shakers. Work with a leading source of help and information in this growing field . . . contact MB. For details and specifications on MB Exciters, send for Bulletin 420-7.

MB manufacturing company
A division of Textron American, Inc.
1060 State Street
New Haven 11, Conn.

HEADQUARTERS FOR PRODUCTS TO ISOLATE VIBRATION . . . TO EXCITE IT . . . TO MEASURE IT.

modern design specifies stainless steel

McLouth
STAINLESS
Steel



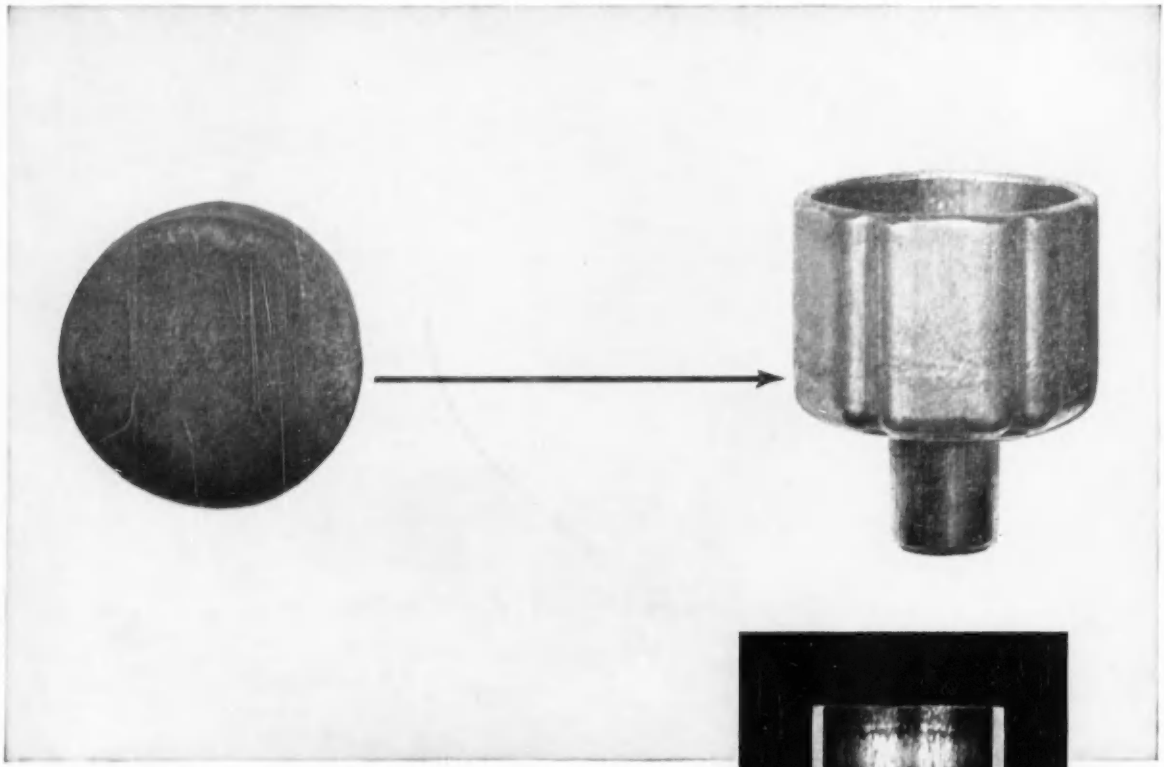
for automobiles

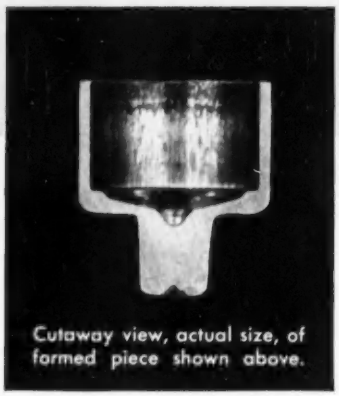
The beautiful bright molding and trim that style your car are made of non-corrosive, easy to clean Stainless Steel. Designers of automobiles and hundreds of other products specify Stainless Steel for its many valuable properties.

For the product you make today and the product you plan for tomorrow specify McLouth high quality sheet and strip Stainless Steel.

McLouth Steel Corporation
Detroit, Michigan

MANUFACTURERS OF STAINLESS AND CARBON STEELS





Cutaway view, actual size, of formed piece shown above.

COLD FORMED IN ONE OPERATION

—with Bonderite and Bonderlube!

An experienced production man looked at this blank and the formed parts and said flatly, "It can't be done!" But *it is being done* — in one operation — on a production basis of thousands of units per day.

The blank is treated with Bonderite, and then with Bonderlube. This combination works with remarkable effectiveness.

These two Parker products effect big savings in other ways besides raising production levels. Tool and die breakage declines sharply, fewer process anneals are necessary, operation is simplified, scrap is minimized, and machining operations are reduced.

Cold extrusion, with Bonderite and Bonderlube, may hold the key to cost-cutting for you. Write for information!

*Bonderite, Bonderlube, Parco, Parco Lubrite, Parker Pre-Namel—Reg. U.S. Pat. Off.

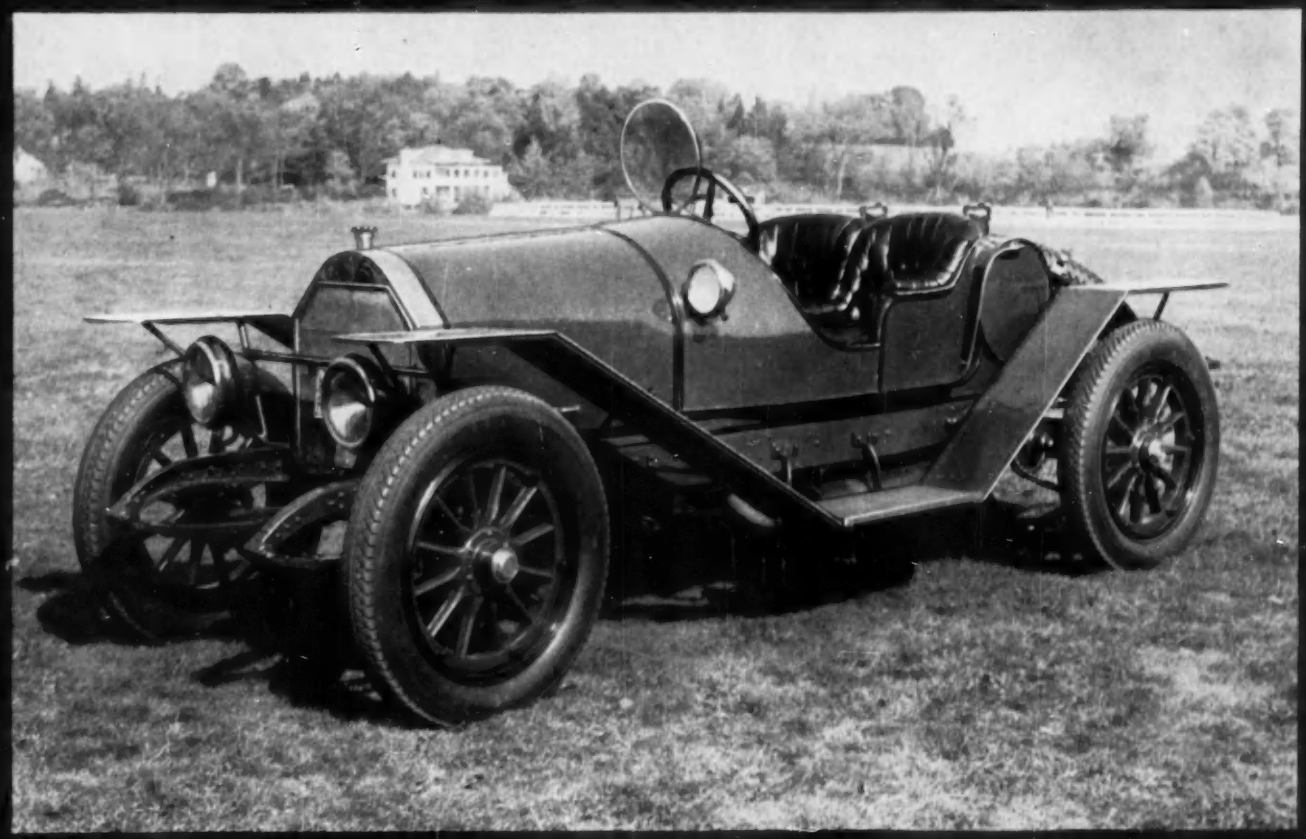
Since 1915—Leader in the Field

1915 40th year 1955

PARKER RUST PROOF COMPANY

2181 E. Milwaukee, Detroit 11, Michigan

BONDERITE	BONDERITE and BONDERLUBE	PARCO COMPOUND	PARCO LUBRITE	TROPICAL
corrosion resistant paint base	aids in cold forming of metals	rust resistant	wear resistant for friction surfaces	heavy duty maintenance paints since 1883



Send For Free Print—1913 Simplex

This "streamlined" 1913 Simplex was almost totally hand-made, with all vital parts of imported chrome-nickel steel. It had a water-cooled, four-cylinder engine rated at 50 h.p., a 126½-inch wheel base, and a double-side chain drive.

This is one of a series of antique automobile prints that will appear in future Morse advertisements. Write for your free copy, suitable for framing. Morse Chain Company, 7601 Central Avenue, Detroit 10, Michigan.

Over 60,000,000 Morse Timing Chains insure long service life of cars, trucks, and busses

Manufacturers of thirteen of the seventeen cars which now use timing chain drives specify *Morse Timing Chain Drives* as original equipment. Over the years, more than 60,000,000 of these drives have been supplied by Morse to the auto industry!

Precision-built Morse drives give car, bus, and truck owners long service life—plus freedom from maintenance worries.

If you have problems involving timing chain in design, development or application, check first with Morse. We have expert engineering service available to help you solve them quickly, profitably.

For further information, call, wire, or write: MORSE CHAIN COMPANY, 7601 Central Avenue, Detroit 10, Michigan.

MORSE BW **CHAINS, CLUTCHES, AND COUPLINGS**

Easy Effortless Shifting...

WITH THE NEW Spicer

Advantages of Air-Assist Control with Spicer Synchronized Transmission

1. No change in shifting pattern. Operator goes through motions—air does the work . . . quickly, easily, quietly.

2. In case of air loss, transmission can be shifted manually, going through the regular gear shift pattern.

3. Permits more latitude in design of shift lever to avoid cab interference. The long lever required for proper hand leverage to shift synchronized transmission not required when Air Assist is used.

4. Easily adaptable to any Spicer Synchronized Transmission, as substitution of shift tower only is required. Air Assist cylinder can be assembled at either side of shift lever and air hose connection available at both ends of air cylinder.

5. Only one outside air hose required.

The new Spicer AIR-ASSIST Shift is another Dana Corporation development to make truck and bus operation easier, smoother, safer!

The AIR-ASSIST Shift is available only on Spicer Synchronized Transmissions . . . optional on new equipment, or available as a replacement unit on Spicer Synchronized Transmissions now in use.

The AIR-ASSIST Shift adds another feature to the long list of advantages already offered by the Spicer Synchronized Transmission:

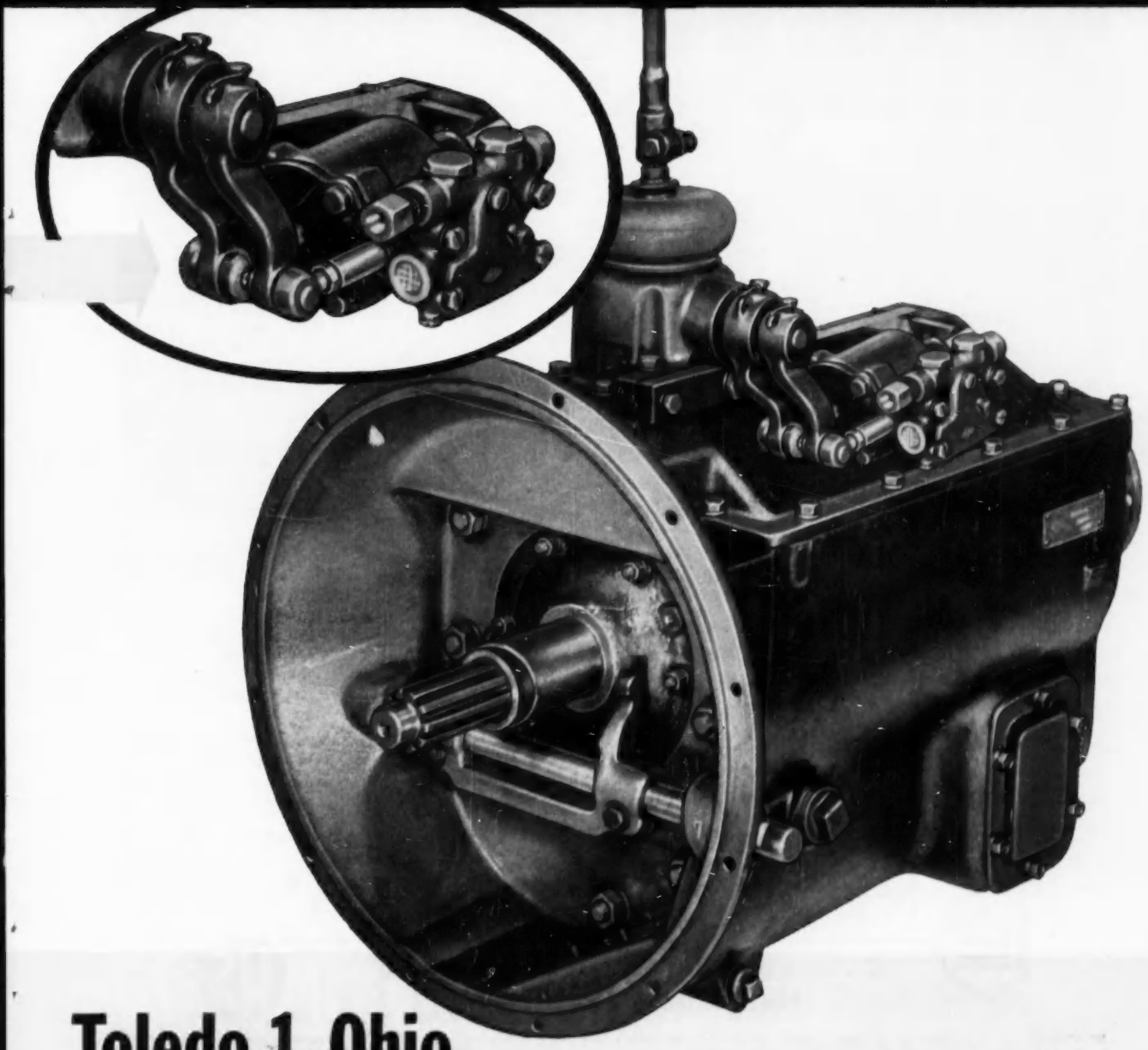
- **Equal Shifts for Driver Convenience**
- **Positive Blocker Type Synchronizers**
- **More Leverage for Ease in Shifting**
- **Alloy Steel Carburized Gears**
- **TOCCO Fork Pads for Long Wear**
- **Gear Hopping Guards**
- **Large Bearings for Long Mileage**

Over 250,000 Spicer Synchronized Transmissions have been installed in heavy-duty trucks and busses, for a wide range of civilian and military services. Ask Spicer engineers to help you adapt the Spicer Synchronized Transmission and the new AIR-ASSIST Shift to your needs.

Spicer **DANA CORPORATION**

AIR ASSIST SHIFT

An exclusive feature of the Spicer Synchronized Transmission



Toledo 1, Ohio

SPICER PRODUCTS: TRANSMISSIONS • UNIVERSAL JOINTS • PROPELLER SHAFTS • AXLES • TORQUE CONVERTERS • GEAR BOXES • POWER TAKE-OFFS • POWER TAKE-OFF JOINTS • RAIL CAR DRIVES • RAILWAY GENERATOR DRIVES • STAMPINGS • SPICER and AUBURN CLUTCHES • PARISH FRAMES

WHY NOT Reinforced Vibrin for...

...complete door liners? ...rigid automobile tops? ...station wagon trim?

Easily formed door liners of reinforced Vibrin polyester would even include the arm rest. Practically mar-proof, they need no painting or upholstering. And they're always pleasant to the touch. **Translucent tops** of reinforced Vibrin provide pleasant, uniformly lit interiors without uncomfortable heat ...without sun glare. They can be permanently mounted or removable. **Wood-like grained station wagon trim** of reinforced Vibrin can't rot...never needs waxing or other protection. Formed to stylish contours it serves as additional protection for the sides.

...seat back panels? ...hood and trunk sections? ...grille work for trucks?

Attractive, scuff-proof seat back panels of Vibrin need no upholstery—wipe clean with a cloth—give all the protection desired. **Hood sections** of reinforced Vibrin would help eliminate engine noise as well as problems in counterbalancing, in hinging, in fabricating complex fairings for air intakes.

Why not reinforced Vibrin for truck fenders, cab-over-engines? Why not reinforced Vibrin grille work? Why not window trim, instrument panels, seat bases...?

Why not reinforced Vibrin® for the many applications where its strength, light weight, beauty, and formability can not only improve your product and add to its saleability, but reduce your costs at the same time!

Reinforced Vibrin is...

- dent-proof
- rust-proof
- rot-proof
- stronger than steel by weight
- resistant to gas, oil, most chemicals
- highly resistant to abrasion and impact
- unharmed by extremes of weather
- extremely light in weight
- integrally colored
- easily molded to complex contours

Write for our free booklets on the molding, use, and many advantages of reinforced Vibrin polyester.

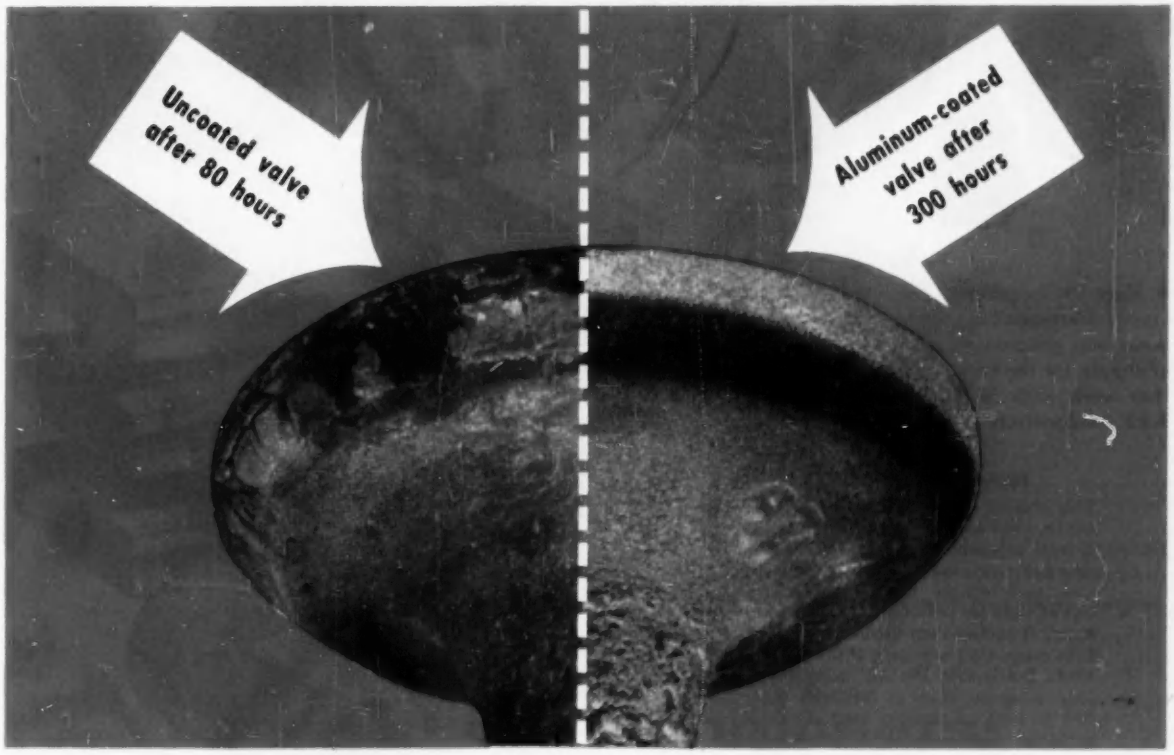
Naugatuck Chemical

Division of United States Rubber Company

Naugatuck, Connecticut

BRANCHES: Akron • Boston • Charlotte • Chicago • Los Angeles • Memphis • New York • Philadelphia • IN CANADA: Naugatuck Chemicals, Elmira, Ontario
Rubber Chemicals • Synthetic Rubber • Plastics • Agricultural Chemicals • Reclaimed Rubber • Latices • Cable Address: Rubexport, N. Y.

Thompson triples valve life!



Thompson aluminum coating* increases valve life 2, 3, even 4 times

Corrosion of exhaust and intake valves by hot gases and fuel residues can be greatly reduced by the Thompson method of aluminum coating* the steel. Tests show that valve life can be increased as much as 186%, and that engine performance is kept at near-original level longer.

The Thompson method of aluminum coating provides penetration of the valve steel by the aluminum for maximum corrosion protection of the valve face.

Ask your Thompson sales-engineer for the complete story and engineering data on this newest Thompson system of aluminum coating engine valves. Or write to:

** Processed under license by General Motors Corporation*

Valve Division Thompson Products, Inc.

DEPT. VS-1255, 1455 EAST 185th ST. • CLEVELAND 10, OHIO

7,000 ITEMS A KEY TO K&E LEADERSHIP

Drafting, Reproduction, Surveying,
Optical Tooling Equipment and Materials
Slide Rules Measuring Tapes

● **Since 1867 engineers, scientists, designers, surveyors, draftsmen have relied on K&E as the foremost, most progressive, and most complete source of supply for the tools, equipment, and materials they work with. When you buy, think first of K&E, headquarters for 7,000 items. For example...**

ZEISS Ni2
SELF-LEVELING LEVEL

This amazing new instrument cuts leveling time and costs in half. It sets a line of sight precisely level *automatically*. A remarkable new invention, the Compensator, built into the telescope levels the line of sight for you in a matter of moments. It performs any kind of leveling, from rough cross sectioning to first order work. Bench-mark leveling, using two rods, is almost twice as fast with the Ni2 as with an ordinary level. Cross-sectioning with many sights from one set-up is even faster. Accurate up to ± 0.02 ft. per mile, the Ni2 is as rugged as its appearance suggests.

KEUFFEL & ESSER CO.
New York • Hoboken, N. J.
Detroit • Chicago • St. Louis • Dallas • San Francisco • Los Angeles
Seattle • Montreal
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moraine engineering

A new and improved spacer for shock absorbers that is now being made in one press operation—with substantial economies for a Moraine customer.

Amazes even engineers!

People sometimes find it hard to believe us when we tell them that parts like these can be made from metal powder in one press operation. Then they're amazed to see us make these and other equally complicated parts easily, economically, in quantity. And when they learn about the over-all advantages — *Improved product performance . . . Lower unit cost . . . Dependable, on-time quantity delivery . . . Engineering assistance . . . Savings in customer investment in equipment and floor space* — they are convinced that Moraine engineering and metal powder techniques may offer real solutions to their own problems.

Moraine products include: Moraine-400 bearings, toughest automotive engine bearings ever made— Moraine friction materials — Moraine metal powder parts — M-100 engine bearings and Moraine conventional engine bearings — Self-lubricating bearings — Moraine porous metal parts — Moraine power brakes — Delco hydraulic brake fluids — Delco master cylinders, wheel cylinders, lined brake shoes and parts.

moraine products
DIVISION OF GENERAL MOTORS, DAYTON, OHIO

MICROHONING*

PRECISION

in millionths of an inch

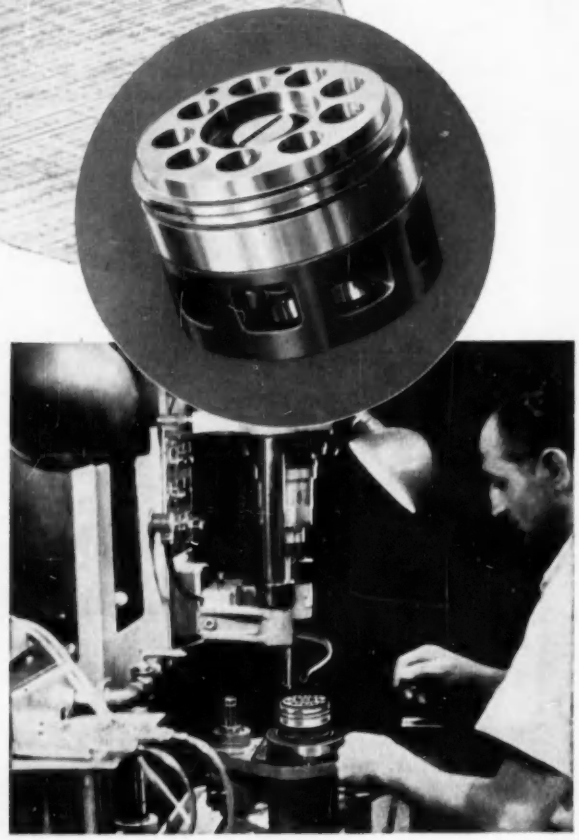
MICROHONING is inherently the most accurate of all production methods used for stock removal. Four major characteristics make Microhoning the controlled abrading process—that produces precision in every part.

Low velocity abrading technique
—low speeds (50-250 SFPM) minimize heat and surface stresses.

Sharp cutting abrasive grits at all times
—the self-dressing action provides clean, constant cutting and uniform surface finish.

Self-alignment of tool with bore
—use of the "float" principle . . . either the tool or workpart has universal action . . . automatically aligns tool and bore to correct bore inaccuracies without changing bore location.

Large area of abrasive in constant contact with work surface
—cutting pressure is evenly distributed over the surface by the thousands of minute abrasive grits collectively removing substantial amounts of stock. There is no localized heat to damage the surface or sub-structure of the metal.



An aircraft hydraulic pump block component, made up of cast iron and hardened steel (58-60 Rockwell "C"); nine ported cylinder bores are Microhoned to obtain surfaces which will maintain a "running" seal and which will not gall or "pick-up." From .006" to .008" stock is removed from each bore while holding these tolerances:

geometry—.000025"
diameter—.000050"

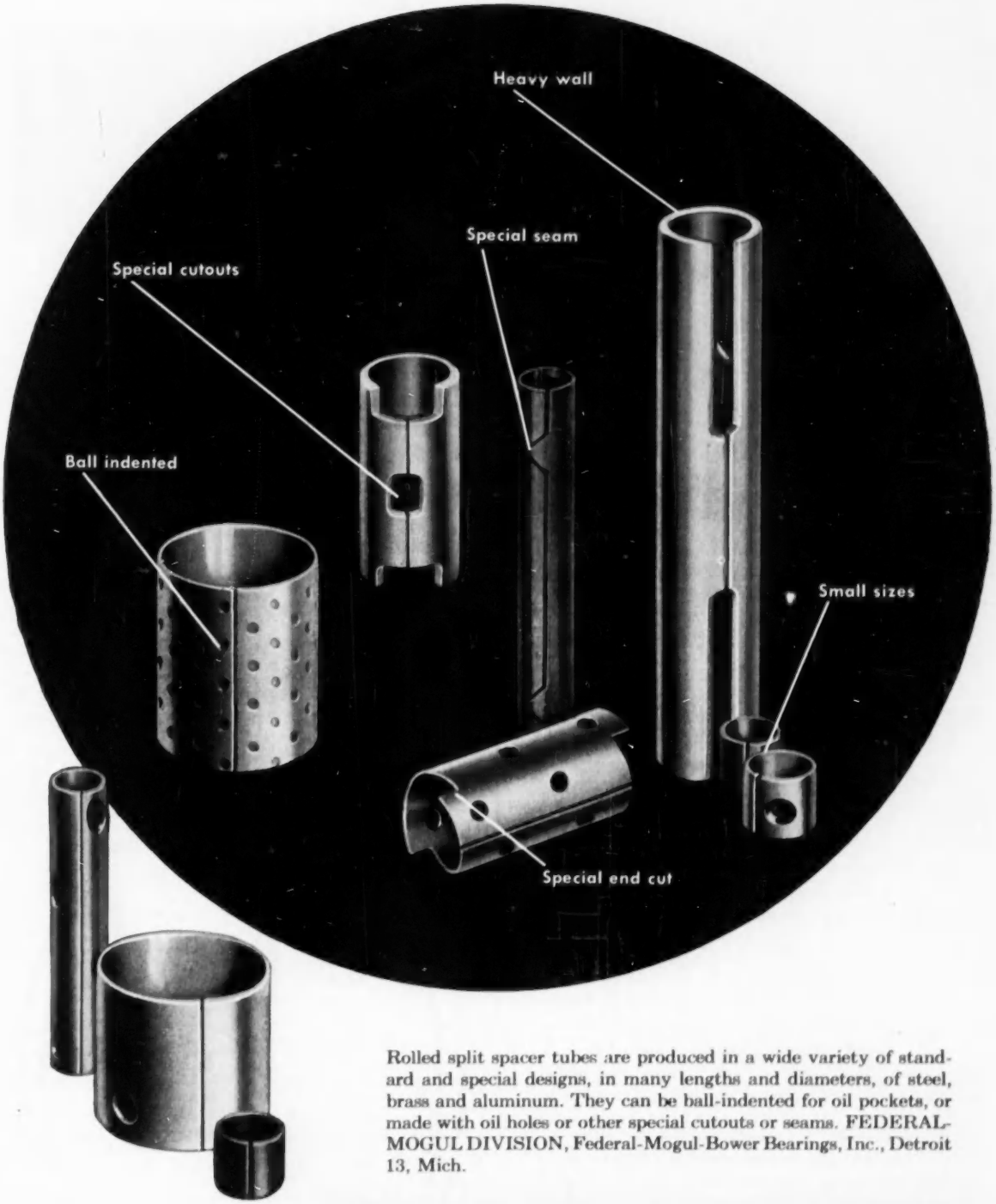
Steel surface finish is held under 8 microinches; cast iron, under 10 microinches. Bores of both sections are Microhoned in line in the same operation.

For a more complete story on this application, write for CROSS-HATCH, Vol. 7 No. 4.

*MICROHONING = Stock Removal + Geometry + Size Control + Surface Finish

MICROMATIC HONE CORPORATION

8100 SCHOOLCRAFT AVENUE • DETROIT 38, MICHIGAN



Rolled split spacer tubes are produced in a wide variety of standard and special designs, in many lengths and diameters, of steel, brass and aluminum. They can be ball-indented for oil pockets, or made with oil holes or other special cutouts or seams. FEDERAL-MOGUL DIVISION, Federal-Mogul-Bower Bearings, Inc., Detroit 13, Mich.

FEDERAL Mogul since 1899

FEDERAL-MOGUL

Sleeve bearings, bimetal rolled split bushings, plain steel or bronze rolled split bushings, bearing-surfaced washers.

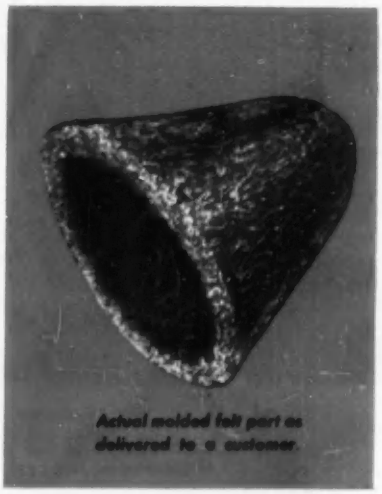
+ INDEX TO ADVERTISERS +

felt...

Strip of felt from the molding press

molded into special shapes

American *felts* are moldable felts. Molded felt parts eliminate fabricating problems of stitching, cementing or stapling. They also provide one-piece integrated assemblies at lower cost for superior service where a compact, permeable shaped part is needed which will breathe, cushion, filter, seal, wick or lubricate. Review your material requirements and let our engineers apply this property of felt to your new design projects or to existing parts.



Actual molded felt part as delivered to a customer.

American Felt Company

TRADE MARK ®

GENERAL OFFICES: P. O. BOX 5, GLENVILLE, CONN.

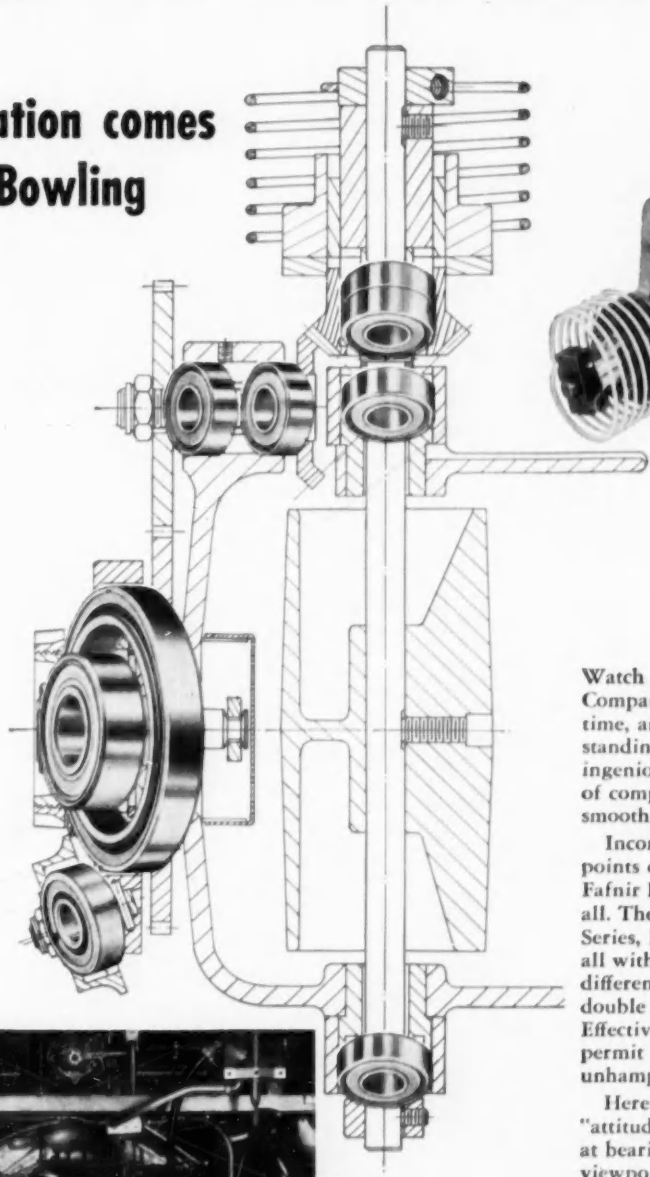
SALES OFFICES: New York, Boston, Chicago, Detroit, Cleveland, Rochester, Philadelphia, St. Louis, Atlanta, Dallas, San Francisco, Los Angeles, Portland, Seattle, Montreal.—PLANTS: Glenville, Conn.; Franklin, Mass.; Newburgh, N. Y.; Detroit, Mich.; Westerly, R. I.—ENGINEERING AND RESEARCH LABORATORIES: Glenville, Conn.

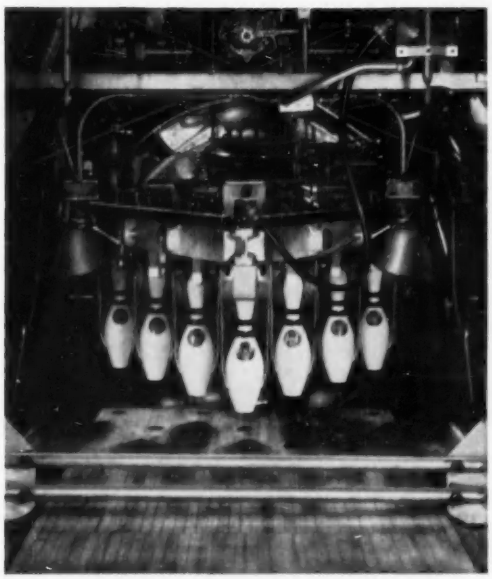
WRITE for our recommendation of a molded American Felt part to your specifications.

Turning Points to more Efficient "Pin Boys"!

Automation comes to Bowling

Section of Pin Distributor Drive Head Assembly equipped with six Fafnir Extra Small Series Double-Shielded Ball Bearings including a duplex arrangement plus a 200 Series Plya-Seal Bearing located in housing within an Aircraft Type Bearing . . . also another 200 Series Bearing with Plya-Seals.





AMF Automatic Pinspotter is shown in process of lowering pins.

Watch an American Machine & Foundry Company Pinspotter in operation sometime, and you'll agree that it's an outstanding example of automation. This ingenious machine performs a multiplicity of complicated operations with amazing smoothness and dependability.

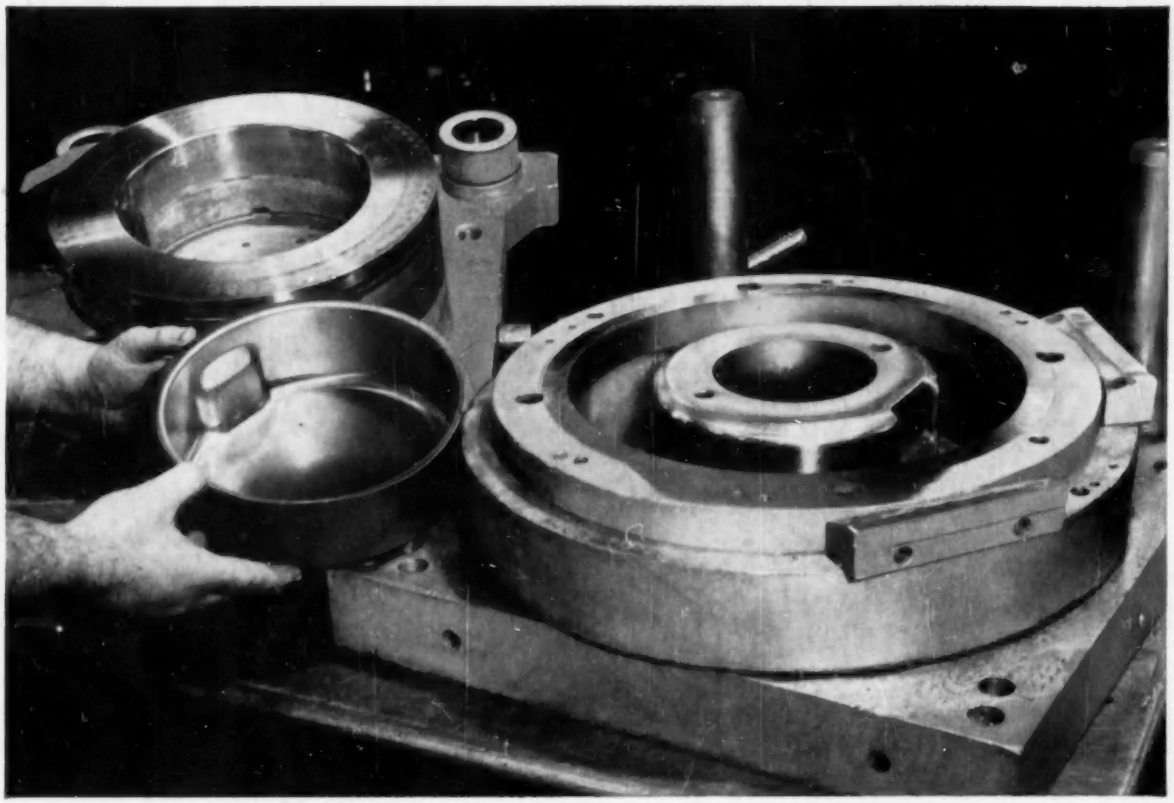
Incorporated in many of the turning points of the Automatic Pinspotter are Fafnir Ball Bearings . . . forty of them in all. They include several sizes of the 200 Series, Inch Type, and Extra Small Series, all with double grease shields . . . also three different Aircraft Type Ball Bearings with double Plya-Seals and a Flangette. Effectively placed, these ball bearings permit precise coordination of motion unhampered by friction.

Here is another example of the Fafnir "attitude and aptitude" . . . a way of looking at bearing problems from the designer's viewpoint, plus coming up with the right bearing to fit the need. Automation problems and solutions are part of Fafnir's industry-wide experience. If you need the advantages of such experience, let Fafnir help you. The Fafnir Bearing Company, New Britain, Conn.

FAFNIR

BALL BEARINGS

MOST COMPLETE LINE IN AMERICA



General Electric Department keeps blank and deep draw rejects under 3% with Graph-Mo® tool steel die

AIR chambers for General Electric Swivel Top Cleaners require a 3⅛" deep draw. Yet they have to be stamped out rapidly with a minimum of rejects to keep up with production requirements. General Electric Vacuum Cleaner Department in Cleveland, Ohio, turns out an average of 333 air chambers per hour with less than 3% rejects by using a Graph-Mo® tool steel die.

Rejects are held down because Graph-Mo tool steel has a unique structure, diamond-hard carbides, plus unusual ability to retain lubricants on the wearing surface. This prevents excessive scuffing and galling even in tough draws like this.

Result: The Graph-Mo steel die wears extremely well. Many users report that Graph-Mo steel outwears other tool steels 3 to 1.

Machining is fast because Graph-Mo steel machines 30% easier than conventional tool steels. And it has uniform response to heat treatment, completely eliminating distortion.

Graph-Mo is only one of four graphitic tool steels developed by the Timken Company. For more information about all of their uses in dies, punches, gages and machine parts, send for the new 10th edition of "Timken Graphitic Steel Data Book". Write to: The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable address: "TIMROSCO".

YEARS AHEAD—THROUGH EXPERIENCE AND RESEARCH

SPECIALISTS IN FINE ALLOY STEELS, GRAPHITIC TOOL STEELS AND SEAMLESS TUBING